POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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The Adler Planetarium
Chicago, Ill.
Photo by Haveman

The Master of the Show

WHAT IS IT that's more exciting than a trip to the moon, more romantic than twenty thousand leagues under the sea, more beautiful than a poem, more instructive than a week at school? An hour in the Adler Planetarium in Chicago, where anybody can embark any day on a personally conducted tour of the heavens. Here time is turned backwards, or forwards, at one's command. Here the sun, the moon, the planets and the stars obey the will of man. In the space of a few minutes a century of astronomical events are passed before us in review.

It is a most fascinating place and one never ceases to marvel at the strange, grotesque machine that holds the center of the stage—the planetarium instrument itself. In this photograph we see it in a particularly mysterious aspect, a gaunt, sinister monster with eyes of flashing fire silhouetted against the midnight sky. Somehow it makes us think of those lines of the Rubaiyat which speak—

Of magic shadow-shapes that come and go,
Round with the sun-illumined Lantern held
In midnight by the *Master of the Show.*

This, truly, is an astronomer's paradise for here, by the turn of a switch, the ages past and those to come pass before him in review.

We, in our field of endeavor, are not so fortunate as the astronomer in this respect. We cannot predict the future course of development with any degree of certainty. Though we are clever at making instruments and doing things automatically, we cannot, like the astronomer, devise an instrument which at the touch of a switch will trace out the future course of development in our industry.

We can, however, occasionally take stock, and look back over the road we have come, in order better to know where we stand and what we may expect. And so, as we enter upon a new year—a year to which we all look forward with hope, it is fitting that we should review the developments of the year just past.

In terms of values by which we had learned to judge in years past, 1932 made a poor showing. There were no bonuses or extra dividends—no over-loaded units, no shrieking sales records. For most of us it was a year of worry and uncertainty.

But if it denied us the prosperity we had hoped for, it gave us other things which in the end may be of greater value. In bringing us back to earth it gives us a better perspective of where we stand and of the ground that must be covered in the immediate future. And in looking over the developments of the past year, we are not quite so certain that the year 1932 was such an utter failure. Indeed, the pages that follow present an amazing variety of accomplishments in practically every branch of the art, some of them startling and unique. We recommend these pages to your attention. Many of the developments no doubt will be familiar to the engineer who has kept abreast of the times, but to contemplate all of them together according to their respective classifications is an experience that is not only instructive but one which will stimulate a greater interest in the many problems that still remain to be solved.

WITH THE EDITORS

Modernization—Why—How?

WHY MODERNIZE is a fair question. The Committee on Industrial Rehabilitation, composed of shrewd, able business leaders from New York to San Francisco is answering it. Not to increase output, although it should put you in the way to care for more business as demand increases. Not just to spend money for the sake of increasing business activity. But to reduce costs, to improve competitive condition and to make a profit on present business. Waste in power use, in production methods, in handling material and products is costing money—now—and will as long as modernization is neglected.

Self interest and sound investment should be the determining factors but indications are that business is reaching for a turn upward, that modernization can be achieved now at a low or lower cost than later.

Approach to the problem is by analysis of present methods and equipment and comparison with the best available. For convenience it may well be taken up under headings such as: Buildings, construction, arrangement, heating, ventilating, lighting, Production methods, processes, equipment, arrangement, routing and methods of handling and transporting raw materials and products. Power, generation, transmission, motor equipment and control, lighting system control, boiler plant, auxiliary equipment, steam lines, valves and fittings, mechanical transmission by belts, chains, shafting, couplings and speed reducers. Maintenance, lubrication, repairs, replacements, routine of inspection. Merchandising, packing, shipping, sales, office methods and records.

By such study and analysis almost certainly some, probably several, perhaps many points will be uncovered where modernization will reduce waste, cut cost and improve product. If, by a miracle, no such points are discovered, the assurance is gained that your plant and organization are in the best shape possible.

The Committee is organized to give any assistance possible in getting such analysis under way. It has prepared a check sheet to help in carrying on the work and to suggest details for investigation, which may be had from Joseph Dilworth, managing director, 435 7th Ave., Pittsburgh, Pa. The Why and the How of a modernization program for every industrial plant are well answered. The question before the individual plant is When?

Cahokia

TEN YEARS AGO last September the first pile was driven for Cahokia Station, an event as important in power plant history as the little village for which it was named was in early frontier history. The second central station to rely on pulverized fuel, Cahokia has generated over 6 billion kw-hr. and is still one of the foremost American power plants.

Starting originally with the central or bin system designed to burn low fusing ash coal, Cahokia was one of the early advocates of unit firing and pioneered the horizontal turbulent flame burner. A brilliant chapter in water-wall history was also written at this station. Later this work made it possible to rebuild the original boilers to generate twice as much steam and double the turbine capacity in the original section of the building.

By forging ahead always feeling that improvements were possible, taking full advantage of contemporary developments and breaking the trail when necessary, Cahokia has carved a niche high up on the rock reserved in history to record the rise of electric power.

An Opportunity Is Opened

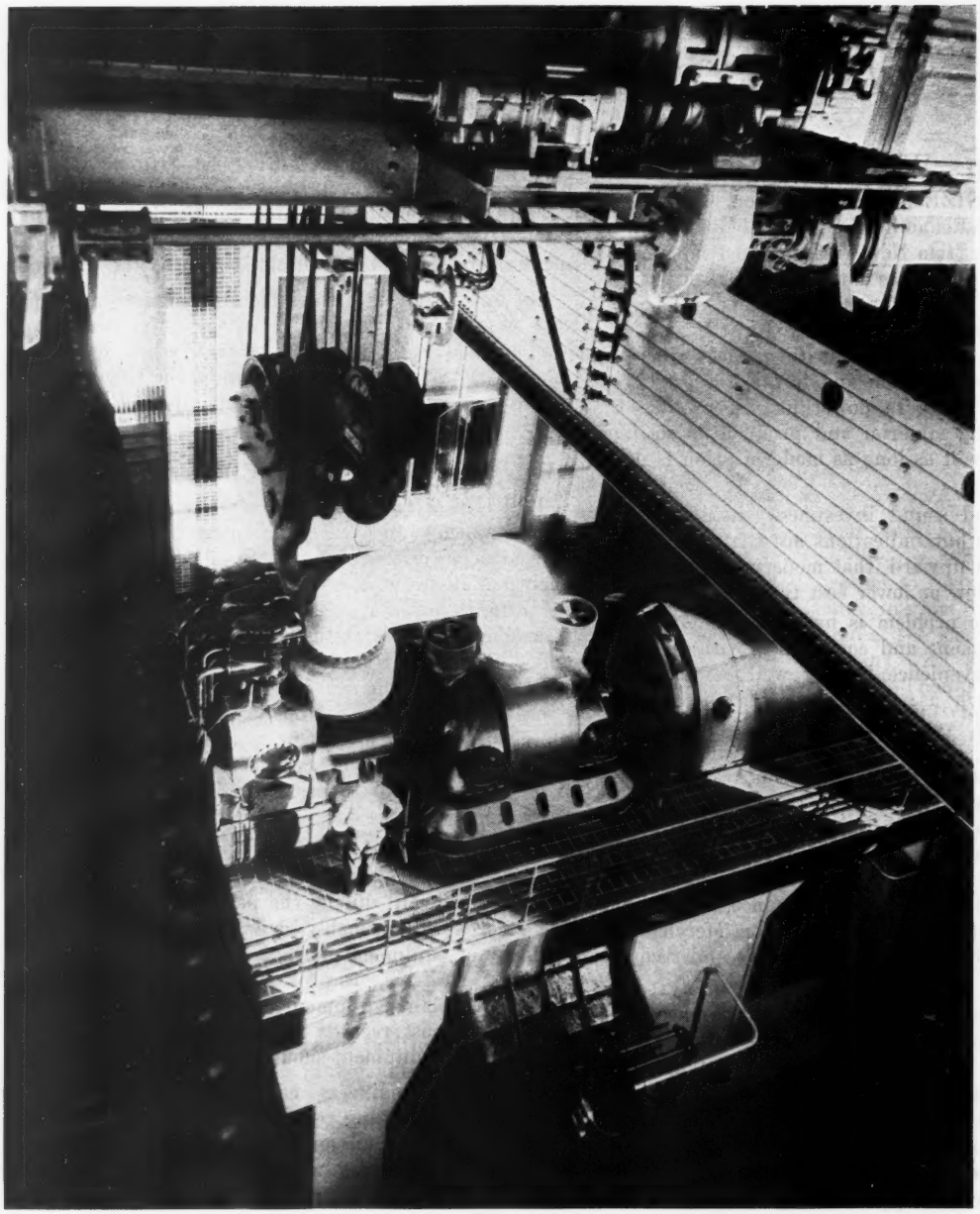
DURING THESE TIMES of economic stress many office buildings and industrial concerns that operate their own power plants have passed into the hands of receivers. Regrettable as this fact may be, the results are in many cases opening opportunities for engineers to demonstrate their abilities which too frequently were denied them under former possibly inefficient management. With the change in officials, and the business affairs under the critical observation of bond holders, all expenses of operation will come in for careful study and reduction wherever possible. And for the power plant, who should be in better position to make recommendations than the chief engineer?

This is the time to delve into the records of the plant and make certain that no detail of expense has escaped revision downward during the period of the depression. The records will probably show a gradual decrease in efficiency of equipment or that growing repair bills are becoming excessive. Improvements may have rendered the present plant equipment obsolete in many respects. A study of past records and comparison with results from modern equipment should determine this.

Competent engineers can predict with amazing accuracy the operating results of all major power plant equipment. This data can readily be translated into the language of the business man who must pass on all items of expense. With data in such form the management can readily make its decisions.

It is to these business men that engineers of building and industrial power plants must submit their recommendations for improvements. They are responsible to the financial backers for the success of the company of which the power plant is but one department and the engineer will be obliged to share that responsibility as regards the power plant. So, in his study of the services he can render to the building or factory and his estimates of the costs involved, accuracy combined with conservatism is essential to success in getting the approval of the management.

Many engineers have felt themselves handicapped in rendering their best services, due to the business reciprocity which has interfered with economic management of their plants. It would now seem that many of these barriers have been broken down and that real opportunities are open to competent engineers.



LOOKING DOWN ON A "CENTURY OF PROGRESS"

The modern steam-electric generating station is truly representative of the slogan, "A Century of Progress" chosen for the World's Fair in Chicago this year. It represents the combined mental and physical effort of numberless thousands of far-seeing men, over more than a century. Highly perfected, highly efficient, it stands today, a dynamic monument to the memory of James Watt, Michael Faraday and the other brilliant pioneers who laid the foundations of our industry.

THE YEAR'S POWER PLANT DEVELOPMENT IN REVIEW

IN THE ELECTRICAL engineering laboratories of Stanford University in California there stands today, a small rectangular cage, with screened sides not unlike those we might have kept rabbits in, when we were boys, but instead of containing bunnies, this cage contains two queer shaped metal gadgets between which is mounted a shaft carrying a small metal cylinder. The latter can be rotated at high speed by a small electric motor on the outside of the cage. The whole thing looks rather ridiculous and offhand, it doesn't seem that it could have any earthly use.

Now, strange to relate, this queer contrivance is a voltmeter and a rather remarkable voltmeter at that for it has an effective range of from 1 to 110,000 volts! Imagine it, a single voltmeter without multipliers, without shunts, capable of measuring, accurately, any potential, direct or alternating, from one single volt to 110,000 volts! It draws no current, it has no detectable temperature errors, and its scale characteristics are perfectly linear! Such an instrument, an electrical engineer might claim could only exist in Heaven, but the fact remains it exists at Stanford University in California—which to many people is almost Heaven.

Engineering Milestones

This is progress. It may seem that this is a peculiar way to start an article—a whole issue if you please, purporting to review the year's progress in the power plant field, and perhaps it is, but it is such things as this—this absolutely new type of electrostatic voltmeter, that constitute the real milestones on the year's road to higher achievement. Of course, progress is of many kinds—a new turbo-generator, one larger than ever built before, also constitutes progress, but it is progress of a more logical, a more orderly nature. To go from a turbo-generator of 100,000 kw. capacity to one of 160,000 kw.; while the actual feat may entail an immense amount of mental and physical effort, in its essence, the move is one we might expect, assuming our faith in the continuous development of engineering achievement. But to make a voltmeter out of a rabbit cage and a revolving peanut roaster, is something, if not startling, at least unique and because it incorporates an entirely new principle, has in it new potential capabilities.

And so, in presenting a brief general review of the year's developments we are inclined to emphasize those developments which are revolutionary even though some of them in the present state may be commercially impractical. The more prosaic developments, however, must not be neglected and in the articles that follow you will find them fully covered, but here, in this preliminary survey we will consider also some of those developments which may be regarded as just in their infancy.

Economic Progress

As a matter of fact, it is well known that there has been comparatively little of the "conventional" type of progress in the power plant field this year. There has been little new construction, and although one or two units of larger size than those previously built were placed in service, for the most part, these had their inception in the preceding year. In the field of actual operating practice there has been little change. Refinements have been added, economy has been increased by anywhere from a fraction of a per cent to several per cent, but on the whole practice this year has followed along lines laid down in previous years. So it is in the new researches which are being carried out, in the fundamental investigations that are under way that we must look for the real progress upon which the future of the industry largely depends.

Boilers—Excess Pressure, Rotary, Explosive, Binary Vapor

In boiler practice, some extremely interesting investigations are being undertaken. At Purdue University, for instance, tests on the high-pressure boiler installed there have been continued. This year, the investigations were concerned mainly with the measurement of the heat content of steam by the use of a condensing calorimeter designed for pressures up to 3500 lb. An interesting feature of this high-pressure installation at Purdue lies in the method of control by means of thyratron tubes. This is the first application of this most versatile device to boiler operation but undoubtedly its use in this field will be greatly extended.

One of the most startling developments in the boiler field this year is a combination boiler and turbine revolving on a common shaft—a complete steam power generating unit. This unusual arrangement comes from Germany where an actual unit has been built. The unit is complete in itself, no feedwater pumps being required. While only in an experimental stage, this unit may have possibilities which when developed may profoundly affect the future course of steam power development. Almost equally unique, is the Velox explosion boiler developed in Switzerland which is a steam generator with a pressure charged combustion chamber, operated in conjunction with both a gas and steam turbine.

In this country the two mercury vapor plants at Schenectady and Kearny are being regarded with great interest, though both plants are still under construction. At Schenectady considerable process steam will be

developed and it is reported that the mercury-steam cycle adopted will come close to the 100 per cent theoretical efficiency mark. The estimated cost is said to be only $69 per kilowatt.

A significant thing in this year's survey of boiler plant practice is the fact that the highest steam pressure used in a commercial installation, is in an industrial plant. This is the 1840-lb. plant of the Philip Carey Co., which is significant because it is an excellent example of a general tendency on the part of industrial plant operators to adopt the practices which have proved successful in central stations during the past few years. This is particularly true in the boiler plant. Where prime movers are concerned, this year's survey of stations indicates a preponderance of engines in the small industrial plant. This may or may not indicate a general trend but it does show increased activity in the small industrial plant. In central stations there have been no new or startling developments during the year. The 160,000-kw., single-shaft turbine which was placed in service at Hudson Avenue, is the largest now in use. The 18,000-kw., 3600-r.p.m. unit at Burlington Station, placed in service during the year, also is believed to be the largest unit operating at this speed in this country.

A notable degree of standardization is apparent in central station heat balances this year, although some innovations are promised in stations to be completed next year. The most interesting and notable plant in this year's list is "K" Street where extracted steam is sold at two pressures, 125-lb. and 20-lb., for process and heating. At Huntley No. 2 station an excellent record for economy was obtained when tests on two 80,000-lb. per hr. units operating at 465-lb. pressure showed a heat rate of 12,600 B.t.u. per kw-hr. In the industrial field the 1800-lb. Philip Carey plant already mentioned, with two 4000-kw. triple expansion engines holds the center of interest and the heat balance, using two industrial evaporators or heat transformers, is an interesting one. For plants concerned with modernization, Pennsylvania Sugar and Hollingsworth and Whitney both offer excellent examples of superimposing new high-pressure equipment on an old plant, making use of the old equipment and at the same time not materially disturbing the heat balance.

GENERAL DATA ON STATIONS

NAME OF STATION	DESIGNING ENGINEERS	COMPANY		LOCATION	TYPE PLANT	CAPACITY		VOLTAGE		FUEL	CONDENSING WATER
		HOLDING	OPERATING			PRESENT	ULTIMATE	GENERATED	TRANSMITTED		
QUINDARO	BURNS & McDONNELL ENGINEERING CO.	———	BOARD OF PUBLIC UTILITY	KANSAS CITY	CENTRAL STATION	10,000 KV-A.	100 000 KV-A.	13,800	13,800	COAL	MISSOURI RIVER
K STREET	UNITED LGT. & PWR ENG. & CONST. CO.	THE UNITED LGT. & POWER CO.	IOWA NEBRASKA LGT. & PWR. CO.	LINCOLN NEBRASKA	CENTRAL STATION	12,000 KV-A AT 70% P.F.	———	4,150	4,150	COAL, NAT. GAS, AND OIL	COOLING TWRS. & DEEP WELL
HARDING ST	THE MANAGEMENT & ENGINEERING CO.	THE UTILITIES PWR. & LGT. CORP.	INDIANAPOLIS PWR. & LGT. CO.	INDIANAPOLIS INDIANA	CENTRAL STATION	73,500 KV-A	157,000 KV-A.	13,800	132,000	COAL	WHITE RIVER
CODY	SARGENT & LUNDY INC.	MIDDLE WEST UTILITIES CO.	N'WEST. PUBLIC SERVICE CO.	NORTH PLATTE NEB.	CENTRAL STATION	3000 KV-A.	?	6,800	6,800	GAS & OIL	DEEP WELLS
PASADENA	LIGHT DEPT., CITY OF PASADENA	CITY OF PASADENA	MUNICIPAL LGT. & POWER DEPT.	PASADENA CAL.	CENTRAL STATION	60,000 KV-A	100,000	16,500	16,500	FUEL OIL & NAT. GAS	COOLING TWRS.
KIDDER	OTTERTAIL PWR. CO.	OTTERTAIL POWER CO.		WAHPETON N. DAKOTA	CENTRAL STATION	10,500 KW.	AS REQUIRED	2,400 & 6900	38,000	COAL & LIGNITE	RED RIVER
DODGE CITY	SARGENT & LUNDY INC.	NO. AMER. PWR. & LGT.—MIDWEST UTILITIES CO.	KANSAS PWR. & LIGHT CO.	DODGE CITY KANSAS	CENTRAL STATION	6000 KW.	25000 KW.	13,800	34,500	GAS & OIL	DEEP WELLS
HOLLINGSWORTH & WHITNEY CO.	CHAS. T. MAIN INC.	HOLLINGSWORTH & WHITNEY		WINSLOW MAINE	INDUSTRIAL	5,000 KW.	AS REQUIRED	600	600	COAL	RIVER
PHILIP CAREY MFG. CO.	W.E.S. DYER	PHILLIP CAREY MFG. CO.		LOCKLAND OHIO	INDUSTRIAL	7,500 KW.	AS REQUIRED	2400	2400	COAL	NON-CONDENSG.
PURDUE UNIVERSITY	PURDUE UNIVERSITY ENGINEERS	PURDUE UNIVERSITY	PURDUE UNIV. SERVICE DEPT	WEST LAFAYETTE INDIANA	INSTITUTION	3500 KW.	6000 KW.	2,300	2,300	COAL	WELLS & COOLING POND
WEST FARGO	ARMOUR & CO.	ARMOUR & COMPANY		WEST FARGO N. DAKOTA	INDUSTRIAL BOILER PLANT	NO GENERATING EQUIPMENT INSTALLED				COAL	———
RADFORD	WILEY & WILSON	LYNCHBURG FOUNDRY CO.		RADFORD VA.	INDUSTRIAL	950 KW.	NONE PLANNED	250 D.C.	250 D.C.	COAL	PRESENT—NONE FUTURE—RIVER
PENNSYLVANIA SUGAR CO.	ENGINEERING DEPT. PA. SUGAR CO.	PENNSYLVANIA SUGAR CO.		PHILADELPHIA PA.	INDUSTRIAL	5500 KW.	NONE PLANNED	2300	2300	COAL OR OIL	NON CONDENSING
CLARIDGE HOTEL	?	THE SEALANDS CORP.		ATLANTIC CITY N. J.	HOTEL	600 KW.	600 KW.	220 V.	220 V.	COAL	NON CONDENSING
PILGRIM HOSPITAL	DEPT. OF PUBLIC WKS. STATE OF N.Y.	STATE OF N.Y.	DEPT MENTAL HYGEINE	BRENTWOOD L.I., N.Y.	INSTITUTION	3781 KV-A.	5281	2400	2400	COAL	NON CONDENSING
LONGVIEW HOSPITAL	DEPT. OF PUBLIC WKS. STATE OF OHIO	STATE OF OHIO		CINCINNATI OHIO	INSTITUTION	387 KV-A.	?	2300	2300	COAL	NON CONDENSING
CHASE BRASS AND COPPER	CHASE BRASS & COPPER CO.	CHASE BRASS & COPPER CO.		EUCLID OHIO	INDUSTRIAL	TRANS. CAP. 7500 KV-A.	15000 + KV-A.	PLANT DISTRIBUTION 4600	33 000 V.	COAL	———
BRUNSWICK LAUNDRY	P.O. SIMEONE & CO.	BRUNSWICK LAUNDRY		JERSEY CITY N. J.	INDUSTRIAL	1100 KW.	NOT DECIDED	125 D.C.	125 D.C.	COAL	NON CONDENSING
SPRINGWELLS PUMPING STATION	DETROIT DEPT. OF WATER SUPPLY ENGINEERS	CITY OF DETROIT DEPT OF WATER SUPPLY		DETROIT MICH.	POWER FOR PUMPING PLANT	10000 KW.	20,000	4,600	4,600	COAL	RAW DETROIT RIVER WATER
NOTRE DAME	ALBERT KAHN INC.	UNIVERSITY OF NOTRE DAME		NOTRE DAME INDIANA	INSTITUTION	NO ELECTRICAL GENERATION				COAL	———

Electric generating practice has not undergone very much change during the year, though in the electrical field as a whole there have been many new and startling developments. The voltmeter referred to at the beginning of this article is only one of many equally unusual productions evolved during the year. In point of capacity, the 200,000-kv-a. generator placed in operation at Hudson Avenue, this year, holds the world's record. This machine is designed along conventional lines and comes close to the theoretical build for this type of construction. By the use of certain modifications, however, it seems that units of considerably larger size are possible. By the use of hydrogen cooling, aluminum conductors and synchronous condensers operated permanently in conjunction with the generator, manufacturing company engineers claim that machines of 375,000 kv-a. are possible.

Generator voltages in this country have not gone above the 22,000 v. used in the machines in the Chicago area, but in Belgium this year, a 36,000-v. generator was placed in service. Transmission voltages also have not gone above the 220 kv. now in use on a number of systems in this country. Considerable attention is being given the question of transmission line design and studies in various phases of the subject are under way. A new type of construction, on the Osage-Rivermine's line, utilizing hinged wood cross-arms on steel towers, seems to provide more effective insulation with shorter strings of suspension insulators. Hand in hand with the question of insulation for transmission lines is that of lightning protection and during the year studies in this field have been continued. The portable surge generator has been developed to a high state of perfection and at least one public utility company has purchased one for making tests on its lines.

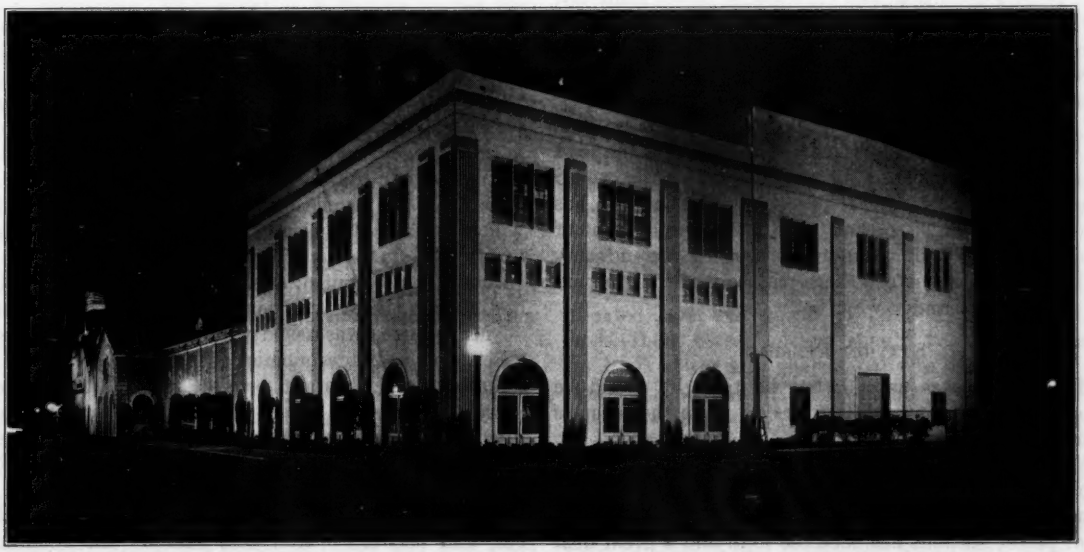
Circuit Protection

The influence of lightning discharges is having an important effect on the design of electrical equipment and this year great progress was effected in the making of surge-proof transformers both for power and distribution purposes. Circuit breaker design also has been improved through the further application of the deion principle. This year breakers of 3 million kv-a. capacity at 220 kv. were placed in service. The deion principle has also been extended for use in other equipment, and a new fuse based on this principle has proved remarkably effective. This fuse is unique because of the fact that it is equipped with a surface condenser. The deion principle has also been incorporated in a new flashover protector for use in guarding the individual insulator strings on transmission and distribution lines.

In the field of electrical measurements many interesting developments have been reported, ranging all the way from such new voltmeters as already mentioned to automatic cathode ray oscillographs for recording unexpected transient phenomena on transmission systems. For calculating short circuit currents on large complicated systems, the calculating board has been improved and this year a large installation was made in Chicago for the Commonwealth Edison Co. Research in insulating materials has proceeded and progress has been made both in the production of better insulating materials and also in our methods of predicting the behavior of insulating materials by calculation.

The year's progress in the field of thermionics, that is, of vacuum tubes, has indicated new possibilities for the use of these amazing devices. The vacuum tube is growing. From the delicate glass tube, that it was a few years ago it has grown into an iron-clad piece of equipment capable of handling a hundred or more amperes of current. Six of these tubes were recently installed in the Salem Street substation of the Boston Edison Elec. Illuminating Co. to supply energy to the direct current network. Many new tubes have made their appearance during the year and many new applications have been found for them. One new tube is so extremely sensitive that it will respond to the inconceivably minute current of six electrons per second!

These are but a few of the developments in the power plant field during the year. There are many others. In this brief survey we have been unable to touch upon developments in the Diesel field or in hydraulics. In both of these branches of the art, progress has been made, the details of which are recounted in other articles in this issue.



PASADENA STATION

POWER PLANT ENGINEERING January 1933

Tendencies in FUTURE POWER STATION *Developments*

An Interview with
WILLIAM S. MONROE
By ARTHUR L. RICE, *Editor, Power Plant Engineering*

AT a time when most of us generally are wondering just what the future has in store for power plant development, it is interesting to get the viewpoint of a man who has spent a lifetime in the design and construction of central stations. In this article, Mr. Monroe, who is president of Sargent and Lundy, Inc., consulting engineers of Chicago, predicts a closer co-operation between the industrial plant and the central station.

THERE IS ALWAYS a satisfaction in talking with Mr. Monroe about conditions in the electric power industry, and we recently had a friendly talk with him in his office about what may be expected as to developments in the immediate future. We are glad that he consented to allow us to publish the substance of the interview.

Mr. Monroe was asked what he thought would be the line of development of electric power stations during the next few years.

"That is an easy question to answer," he said. "I do not think there will be much power station development for some years to come. I am still optimistic about the future of the industry, but it is obvious to any one actively concerned with the power industry, that the large electric central power stations have, for the time being, been overbuilt, just as the factories and equipment of most other industries have been overbuilt. This has not been the fault of the engineers, nor for that matter of the executives of the electric power companies. New installations of large power stations and extensive transmission lines have to be laid out and put under way two to three years before they are to go into operation, and the electric power industry, since its beginning about fifty years ago, had an increase in output and peak loads each year (with one or two insignificant exceptions) and the average increase during the entire period was about 10 per cent per year.

"Scarcely any one in the industry thought it possible that we would see a time when for three years the load and kilowatt-hour output, instead of increasing, would fall off each year by several per cent. This is what has happened since 1929, so that there is a large amount of capacity already built or under way which the industry will have to absorb before there will be many important new stations put under way."

Station Design

Mr. Monroe was asked what he thought would be the tendencies in power station design when there comes a demand for new ones.

"That is hard to say at the present time, because it is looking some years into the future in a rapidly changing world. There is a general feeling, however, that the cost of power stations has been too high and a great deal of effort has been put on various schemes for materially simplifying the building without reducing the efficiency or interfering with the devices for automatic operation. Four of our stations put into operation within the last two years, of which the Sheboygan, Wisconsin, Station is the largest, are steps in that direction.

"Many designs have been made with some of the equipment or even all of it set out of doors, without any building superstructure over. 'Unit stations,' that is, with but a single boiler for each turbine, have been discussed by engineers and manufacturers, and we have made designs for such stations with units up to 150,000 kw. Such power stations would be greatly simplified in piping connections, electrical equipment, and other matters and, if tied to the transmission lines of an extensive interconnected system, would be perfectly practical from an operating point of view and should be very efficient and also very economical as to first cost. They could be strictly 'base-load stations.' But at the present time plans or designs of this character have little more than academic interest and few are likely to be built in this decade."

By-Product Power

After some hesitation, Mr. Monroe went on to say: "There is another type of power station that is likely to be a factor in the electrical industry for some years to come, and that is the so-called 'by-product' power plant, built to supply steam, as well as electric energy, to one or more industries requiring large quantities of steam in their industrial processes. Some of these may be built by one or more manufacturing industries. Some will be built by the electric power companies and others by a joint financial arrangement of the two interests. In over 95 per cent of such cases, however, they should be tied into the electric power system of the district."

Mr. Monroe was asked why that would be necessary. "Because, as an economic proposition, that will contribute to the cheapest possible production of electric power and process steam for such industries," he replied. "In no manufacturing plant which uses steam in its processes, does the demand for steam coördinate or synchronize with the demand for electric power. The daily demand curves for the two are usually very different, and between winter and summer the variation in the demand for steam is very great. The by-product

power plant must be connected to the lines of the electric power company, so that the latter's reservoir of power can take care of the fluctuations in demand. At times when the demand for steam is greatest the high-pressure turbine of the by-product plant would generate more electric power than the factory would require and the excess would feed back into the power company's system; whenever the exhaust steam requirements were less than enough to make the turbine generate the electric energy necessary for the factory, the power company's system would furnish the balance.

"Such plants would, in most cases, require no condensing equipment whatever, because the high-pressure turbine could be run exclusively for the steam requirements of the factory and the electric power generated would be strictly a by-product. Furthermore, in most cases it would be unnecessary to put in more than one turbine, because the power company would always serve as a reserve source of energy, and on the rare occasions when the by-product turbine had to be shut down for overhauling, steam for the factory processes could be taken direct from the boilers through a reducing valve.

Outstanding Example

Mr. Monroe was asked why, if such plants are a good economic proposition, have not many been built already. "It is true," he said, "that only a few such plants have been built thus far and they are mostly small ones or old plants rebuilt for more modern conditions. There is one large plant, however, which was built with this general idea and that is the 'Deepwater Power Station' near Wilmington, Delaware, owned by the combined financial interests of the American Gas & Electric Co., the U. G. I. Co. (Philadelphia Electric Co.), and the DuPont Co. It is, moreover, the largest plant in the world operating with an initial steam pressure of over 1200 lb. per sq. in. Out of a total capacity of 115,000 kw., it has one 15,000-kw., high-pressure turbine, which exhausts into a main supplying process steam to the DuPont Company's factory. The other two 50,000-kw., compound-condensing turbine units are for supplying service to a large electrical distribution system, because the plant is on tide water and is a main generating station for the two power companies. This plant is a tribute to the far-sightedness in matters of power supply of George N. Tidd, President of the American Gas & Electric Co., who originated the project, put the idea over with the other companies involved and effected a harmonious study of the details by the engineers of the different interests.

"When you ask why more by-product power plants have not been built, the answer is that there are relatively few instances where such combinations are possible, also, during the ecstatic days of the last decade, manufacturers were too busy expanding their business and preferred to use possible power plant money to take care of the rapid expansion of their production departments.

"In some such undertakings a basic change in the particular industry has resulted in over-all loss. Many industries have suffered such rebuffs during this depression and they can never resume. The fixed charges on such process plants must be taken at relatively high figures as compared with straight power plant projects in order that evolutionary changes in such a business be reasonably discounted so far as power and heat costs are concerned. Consideration must be given to the geographic location, transportation, labor and material.

"The coming years will be a new era in the electric power industry. That great and important industry has suffered along with others from the effects of the depression but, due to the increasing adaptability of the electric motor and the greater use of electric heating in industry, the supply of electric energy will be even more essential to factories and homes in the coming years than it has been in the past, and the demand will consequently be greater. In these days, the pressure for lower production costs has compelled all manufacturers to make very careful studies of their power requirements and of the economics of their power and heat production where large quantities of steam are needed for processing.

"In practically every case the electric power company is an important factor in the problem and the best solution of such projects can only be effected by a co-operative study on the part of the engineers of the power company and those of the manufacturer. The engineers of the electric power companies are experts in steam production and the use of fuels, as well as in the production of electric power. The use of 'process steam' in a large factory is often a complicated cycle, especially when related to the electric power demand, and utility engineers will, in an increasing number of cases, have to co-operate with the factory engineers of these plants for the interests of both companies."

Binary Vapor Cycle

Mr. Monroe was asked if he thought there would be any development in the so-called "binary cycles" during the next few years. He replied:

"There probably will be when industrial conditions show a distinct improvement. The General Electric Co. has been doing some intensive and effective work on improving the mercury boiler and turbine, and these are likely to be considered in cases where large quantities of process steam are required. Also, the mercury turbine will probably be used for the modernizing of old central stations. There are a great many power stations in this country that have turbines operating on 250 to 350 lb. pressure which are very efficient for the steam range in which they operate. Some of these plants can be vastly improved in efficiency and about doubled in capacity by installing a mercury boiler and turbine in connection with the old steam installation.

"I might add that there are other kinds of by-product power plants which will be built in the near future besides the exhaust steam plants such as we have been discussing. The steel mills and some other industries have large amounts of by-product fuel, such as coke oven gas, blast furnace gas, and waste heat from furnaces of various kinds. Such industries have complicated heat and power cycles and, in practically all cases, their power system should be tied into that of the local power and gas company to effect the most economical use of the fuels available, as well as the most efficient and lowest cost generation of electric power. It will be found that the proper solution of all these problems can only be effected by the engineers of such industry working in harmonious co-operation with those of the electric power company. Undoubtedly there are some prejudices and precedents which may stand in the way for a while, but these can be overcome."

Advances In Steam Generation P

Better understanding and control of boiler circulation. Changes in use of fuels. Increasing availability. Radical foreign boiler designs and advances in mercury vapor practice are some of the oustanding features of the year's development.

STEAM GENERATING equipment has reached the point where it is actually operating at overall efficiencies between 85 and 90 per cent and is so reliable that modern equipment averages an availability of 82 to 86 per cent. These results have been obtained through improvements in details of construction and operation which have continued to advance during the past year. No radical changes have appeared in American practice though in Europe two entirely different and revolutionary ideas have been worked into practical designs.

In designing boilers today first consideration is usually given to the furnace for all sizes of installations and all types of firing. Next the types of heating surfaces surrounding the furnace come in for study. These include all surfaces where heat is transferred from the furnace or gases to the water or steam. Steam drums are then determined as to size on the basis of steam volume and liberating surface.

Central station steam generating equipment of today is usually designed for an overall efficiency of 85 per cent which corresponds to a final exit gas temperature of 400 deg. F. Furnace walls, boiler surface, superheater, economizer and air preheater are so proportioned as to approximate the desired results of steam pressure and temperature and exit gas temperature. Efficiencies around 90 per cent have been attained but the slight gain may be offset in the capital investment involved.

Size and capacity of boilers have not increased over a year ago. Units of 60,000 sq. ft. heating surface are unusually large and those that will deliver 1,000,000 lb. per hour are rare. The record for evaporating capacity today is held by a unit in the 14th St. Station of the New York Edison Co. with an evaporation of 1,270,000 lb. of steam per hour. The maximum boiler operating pressure in practical use remains at 1840 lb. per square inch. Boilers operating at 1200 to 1400 lb. pressure are on the increase but the increase is more pronounced in the 400 to 600 lb. class.

Although 750 deg. F. total steam temperature is generally favored in central stations, temperatures in the neighborhood of 800 to 850 deg. F. are being used and the temperature of 1000 deg. is being experimented with at Detroit.

Bent-Tube Boilers Are Favored

In the plants put into operation during the past year, bent-tube boilers are considerably in the majority and the longitudinal drum appears in only one plant included in our analysis this year.

Reheater practice has undergone no change of consequence during the past year but operating engineers are perfecting their method of operation and control in order to secure most satisfactory service and reliability.

Considerable thought has been given to the problem of boiler water circulation as many engineers have questioned what seemed to be the logical flow of water in the tubes of the boilers. As a consequence we find a number of boilers which have been installed during the year with unusual tube arrangements representing the designers' ideas of the solution to the circulation problem.

While the principal incentive for securing the desired circulation is the higher efficiency attainable due to better heat absorption, the securing of dry steam and elimination of corrosion are byproducts of the circulation problem that are of extreme importance.

Progress in Welding of Boilers

Last year the A.S.M.E. boiler code was amended to permit the fusion welding of high-pressure boilers. This year proposals are being made to extend the use of welding to certain connections, the proposed code specifying the materials allowable for both forged welding and fusion welding. Boilers with welded drums are now being manufactured as standard practice, and with the further developments of X-ray inspection equipment, confidence in this construction is being advanced. It is stated by one welding company that "Welding has progressed from the point where weld metal was virtually all tensile strength and no ductility, to the point where properly made welds contain metal much more ductile than the plate, and still maintain sufficient strength."

Engineers are looking to the increased practice of fusion welding of boiler drums to reduce the cost of high-pressure boilers which would tend to make the use of the high-pressure steam cycle more attractive to plant owners.

High-Pressure Steam Investigations

Tests on the high-pressure boiler installed at Purdue University have been continued through the year, supplementing the data gathered during the previous year. Investigations this year dealt mainly with the measurement of the heat content of steam by the use of a condensing calorimeter designed for pressures up to 3500 lb. per sq. in. The results obtained compare favorably with those of Keenan, Knoblauch and the International Tables but show considerable variance from Callendar's results.

n Practice

One of the most important features of this installation to the operators of power plants is the control system which consists of thyratron tubes and selsyn motors so sensitively adjusted as to regulate oil fuel, air and feedwater flow to maintain steam temperature and pressure without perceptible variation even with extreme variations in load.

Centralized control of boiler operation has progressed during the past year, for with the development of push button control from a location in front of the instrument board, the operator in a boiler plant serving a base-load station where the load does not fluctuate greatly can maintain efficiencies as high as those of a completely automatically controlled plant, in the opinion of many operating engineers.

As a result of an investigation carried on for three years, C. F. Hirshfeld and G. U. Moran report that modern steam-generating equipment may be relied on for use from 82 to 86 per cent of the time and that this state of affairs may be expected to improve somewhat in the future.

Foreign Boilers of Unusual Designs

From Germany comes the development of a steam power generating unit which is a combination boiler and turbine revolving on the same shaft. The heating surface consists of a series of radial loops mounted on cylindrical steam collectors surrounding a hollow shaft. Feedwater is introduced through the hollow shaft, driven by centrifugal force into the return loops called evaporator tubes where it is evaporated by heat from the surrounding furnace and delivered as steam to the steam collectors, thence to a revolving superheater element and on through the hollow shaft to the turbine, the exhaust steam being delivered to a condenser. The pressure of the steam is dependent upon the speed of the turbine ranging as high as 1764 lb. when the speed is 3000 r.p.m. The electric generator is attached to the feedwater end of this shaft by a coupling. Due to the centrifugal force exerted on the water no feedwater pump is required. The unit appears to have many advantages which can be proven only by commercial application.

In Switzerland the Brown-Boveri Co. has developed the Velox explosion boiler which, in principle, is a steam generator with a pressure-charged combustion chamber. In operation the combustion chamber is periodically charged with an explosive mixture of fuel and air supplied to it by a compressor. On the completion of charging, with all valves closed, the mixture is ignited and the pressure in the combustion chamber rises to 4 to 5½ times the charging pressure. When combustion is completed a discharge valve placed at the ends of the heating tubes communicating with the combustion chamber opens, and the chamber begins to empty, the high-pressure gases expanding rapidly through the heating tubes. Water is circulated on the outside of these heating tubes thus absorbing the heat contained in the gases. In this way the water is evaporated and steam generated. The cooled gases are led to the nozzles of a gas turbine in which expansion takes place with the generation of power.

Construction work is still in progress on the mercury vapor plants at Schenectady and Kearny. At Schenec-

tady considerable process steam will be developed and it is reported that the mercury-steam cycle adopted will come close to the 100 per cent theoretical efficiency mark. Such an achievement in a plant estimated to cost only $69 per kilowatt electric generating capacity should encourage the use of this cycle in industrial plants. At Kearny, where process steam will not be used, the cycle efficiency will be only 59 per cent but this is quite an improvement over the 32 to 47 per cent obtainable with steam alone.

At Hartford where as yet the only mercury-steam binary vapor cycle is in actual commercial operation, the operating records for one year showed a heat economy of 10,250 B.t.u. per kw-hr. generated while tests showed that 1 kw-hr. could be delivered at the switchboard for 9930 B.t.u. in the fuel. The units being installed at Schenectady and Kearny are each of 20,000 kw. capacity and will occupy the same space as the 10,000-kw. unit at Hartford, this saving of space being attributed to the use of mercury walls in the furnaces.

Market reports show that mercury output for 1931 increased 15 per cent over that of 1930, while the price declined 24 per cent.

Dowtherm, a chemical consisting of a mixture of the phenolic derivatives diphenyl and diphenyloxide, as a heating medium in process work has been used to advantage by the Dow Chemical Co. where temperature levels of 500 to 700 deg. with pressures of 0 to 100 lb. are desirable. Dowtherm is a non-poisonous liquid that vaporizes at low pressure and has many advantages in industrial heat exchange systems.

Boiler Furnaces Show Little Change

Although the survey does not indicate much change in furnace design from last year, there is a little better understanding of the part played by radiant heat absorbing surfaces with a consequent tendency toward lower furnace volumes or higher heat release per cubic foot of space. One foreign authority is of the opinion that for boilers of small and medium size a comparatively large furnace is an appropriate means of reducing high furnace temperatures due to heat radiation. He would advocate large furnace walls inclined at a favorable angle of radiation to the heating surfaces. He would avoid water and air cooled furnace walls providing only those which would be exposed to the highest grate temperatures and operating at an unfavorable angle of radiation. This opinion does not seem to be held by American engineers whose designs show an increasingly larger percentage of water wall surface.

With the development of single unit pulverizing systems with direct firing came the application of this method of firing in the smaller plants and its use has been continually on the increase in this type of plant. With furnaces completely enclosed by water walls the size has been reduced to the extent that hand fired h.r.t. boilers may be replaced by pulverized coal fired water-tube boilers with considerable increased steaming capacity available. Heat releases of 43,000 B.t.u. per cu. ft. have been attained but 18,000 to 35,000 are most common.

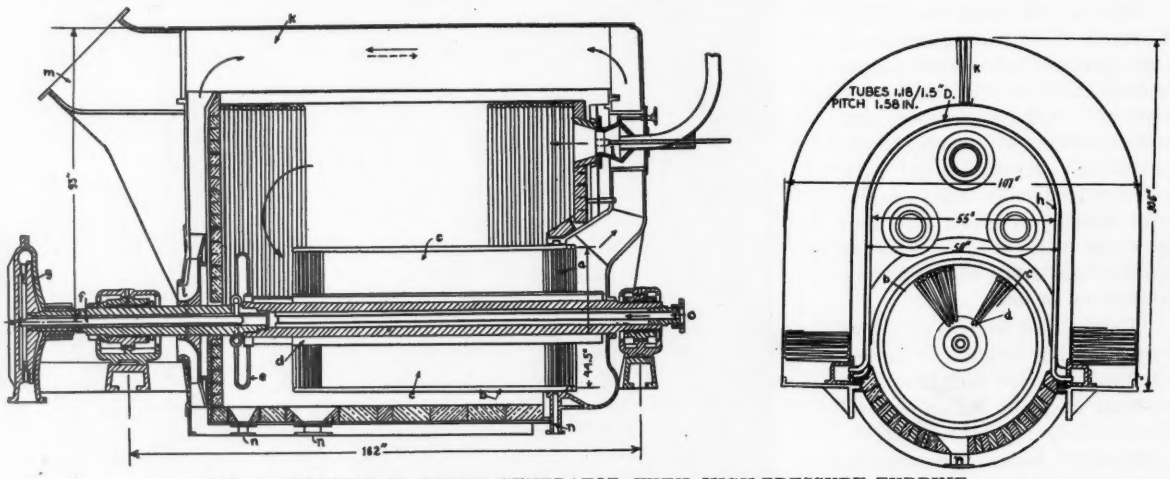


FIG. 1. REVOLVING STEAM GENERATOR WITH HIGH-PRESSURE TURBINE

a, water feed tubes; b, connecting tubes on periphery; c, evaporator tubes; d, steam collector passage; e, high-pressure superheater; f, insulated collector tube; g, high-pressure turbine; h, reheater; i, fresh-air blower; k, air preheater; l, burner; m, flue-gas connection; n, ash and dust hopper; o, feedwater passage through hollow shaft of coupled generator

Considerable difference of opinion has developed relative to the advantages of preheating air for combustion purposes. Advocates of air preheating claim that not only is heat reclaimed from the flue gases but that better combustion is obtained due to the elevated temperature of the air. On the other hand, certain stoker manufacturers insist that increased combustion air temperature is not at all necessary for complete combustion and that the heat reclaimed by the air preheater is only an apparent saving due to working the furnace at a higher temperature, while the higher temperature to which the stoker and refractory is subjected is a positive detriment rather than a benefit. Operating engineers would welcome definite information substantiated by unbiased test data on this subject as it is an economic question confronting every builder of a modern power plant.

Zone Air Control for Stokers

Among the improvements in stoker design worthy of consideration is the provision of zone air control which has demonstrated its practicability in several additional installations. One plant reports that with zone air control combustion rates as high as 90 lb. per sq. ft. per hr. can be secured with air temperature as high as 570 deg. F. Stoker drive mechanisms have also been

improved so that it is now possible to obtain an infinite variation of speeds, within the limits of stoker operation, greatly aiding combustion control.

During 1932 the average size of stokers sold was 330-hp. as compared to 276 hp. in 1930. Reports to the government indicate that stoker fired units are forging ahead as compared with pulverized coal fired units.

Automatic stokers to fit the needs of small boiler plants are now available in almost any modern type; particularly noticeable has been the development during the past year of underfeed stokers for this class of service, several of the reliable concerns having extended their lines down in capacity, to suit the needs of heating plants desirous of replacing hand fired equipment. These stokers retain all the desirable features of their big brothers with the added possibility of intermittent operation.

Considerable attention is being given to the value of clean coal for steam generation. It is recognized that efficient equipment is available to burn coals with ash content as high as 40 to 50 per cent. This however, cannot be done with equipment designed for high-grade low ash content coal. Advance knowledge must be had on the type of coal that will be used before the coal burning equipment is selected. Today, however, the art of cleaning coal has reached a point where, by the use of suitable methods, a coal product can be obtained, at a cost, from high ash coals which are suitable for use on combustion equipment designed for high grade fuel. It is thought that coal operators confronted with the problem of high ash coals will consider the relative advantages of improving their products so as to make them economically suitable to the combustion equipment in more plants, thus enlarging their market.

Developments in Pulverized Fuel Equipment

As a contribution to the art of burning pulverized coal, E. H. Tenney conducted tests comparing turbulent and stream line firing methods from which he draws some valuable conclusions. It is his belief that in order to avoid smoke and slag, with the slow burning, stream line firing considerably greater excess air must be carried than with turbulent burners. This necessity for greater excess air and lower CO_2 is responsible for a difference of 1.5 per cent in operating efficiency.

Several manufacturing companies have recognized the need for small size pulverizing units and have modified their designs accordingly so that they are now available for service on boilers as low as 75 hp. rated capacity.

For the pulverizing of coal, ball mills have been modified in design and operation so as to eliminate lag, making possible the handling of sudden changes in boiler load without appreciable pressure variations.

Handling of coal has not changed in practice at power plants during the past year. Some improvements in the design of coal handling equipment have, however, been made available to users. The use of anti-friction bearings on conveyors is being extended and lubricating methods improved. A new type of vibrator screen has also made its appearance.

Sluicing of ashes from the boiler ash pits to the settling tank or disposal seems to have justified its application if continued popularity is any indication, for it will be observed in the tables that this method, though comparatively new, is used extensively. Some of the important reasons for its application are the small amount of basement space required, the ability to remove ash and fumes without dust, while the labor required is merely that of manipulating valves.

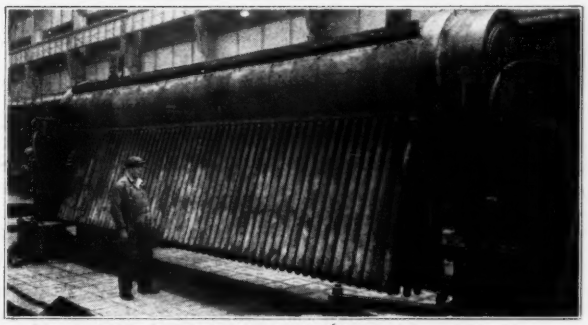


FIG. 2. PORCUPINE-TUBED MERCURY BOILER BEING BUILT FOR USE IN PLANT AT SCHENECTADY

While it is recognized that fuel oil has a place as fuel for power plants, conditions have changed in the refining of crude oil that have altered entirely the quality of the oil formerly sold for power plant use. In other words, Bunker C oil is now likely to contain residues which are causing oil burner troubles particularly with mechanical atomization. Comparisons of the economic value of oil with coal or gas as fuel are needed constantly where such changes in quality are going on.

The completion of the gas lines from the Oklahoma and Texas fields to Chicago and the principal cities in the Mississippi Valley inaugurated the use of natural gas as fuel in many power plants, the change from pulverized fuel being easily made with modern combination burners. As the economies of pipe line transportation require a high load factor, natural gas has become a base load fuel in many plants, some very important base load utility plants being among them. In such plants auxiliary fuels such as oil or pulverized coal are usually provided.

In the near future hearings will be held by the Federal Power Commission on applications as follows: At Everett, Wash., on preliminary permits 890 and 1105 for developments on Sultan and Snyomish rivers by Washington Electric Co., the City of Everett being an objector to issue of the permits. At Tallahasse, Fla., on license 682 for Florida Power Co. to purchase large areas around its project for mosquito control, residents objecting to the grant. In Washington, D. C., on determination of costs of Chippewa Reservoir project 108 to Northern States Power Co., the amount of $200,000 being questioned by the commission.

Illinois is to be issued the first license issued to a state by the commission, covering Brandon Road Dam on the Des Plaines River near Joliet, to develop 32,000 hp. Construction is to start by Jan. 1, 1934 and be completed in 2 yr. The development includes also Dresden Island and Starved Rock dams on the Illinois River, for a total capacity of 90,000 hp. The license, which depended on a ruling of the U. S. Supreme Court recently handed down as to diversion of waters of Lake Michigan, runs for 50 yr.

Ten municipalities hold licenses for major projects, from 166,000 hp. of Seattle, Wash., to 300 hp. of Highlands, N. C. Also 15 licenses are held by municipalities for minor items such as transmission lines.

BOILER PLANT *and* EQUIPMENT DEVELOPMENT

Outstanding Achievements in the art of Steam Generation. Noteworthy Features of Boiler Plants recently put into operation and New Equipment designs of special interest.

BOILER PLANTS of the year show continued application of sound engineering principles developed during the past few years. It will be noted that industrial plants are adopting practices and equipment that have proved successful in central station power plants. In steam pressure, one industrial plant now holds the high-pressure record and all the auxiliary equipment common in central stations is being given consideration and tryouts in new and modernized industrial plants. Several achievements in operation and design have been brought out by this year's survey which indicate definite progress in reliability and efficiency of steam generation.

A STUDY of recent boiler plant developments indicates that the practices and principles which had their origin in and were brought to perfection in the central station field are now being adopted by the industrial type of power plant. Today it is an industrial plant that uses the highest operating steam pressure. ¶ New types of boilers recently developed in Europe involving fundamentally new principles may have an important bearing on the renewed interest in the industrial type of power plant.

That availability of high-pressure boilers can, by proper design and operation, be brought up to that of low and medium pressure units has been definitely demonstrated at Lakeside Station in Milwaukee where three 1390 lb. boilers showed 95.2 per cent availability for an entire year of operation.

Industrial Plant Has Highest Pressure

Several novel features in the design of the Philip Carey steam generating equipment are worthy of note. Steam pressure in this plant is the highest employed in commercial application in this country, 1840 lb. abs., with a total temperature of 800 deg. F. The most unusual feature of the boiler design is the arrangement of the boiler tubes which are attached to headers placed in planes at right angles to each other. The tubes, being bent, allow for expansion and contraction without severe strain. The percentage of heating surface in the water walls is extremely high, far in excess of any other plant tabulated this year except the boilers in the Pennsylvania Sugar Co. plant. With the provision of economizers and air preheaters, the exit gases are brought down to a temperature of 250 deg. F.

The boilers are fired with pulverized coal, the furnace bottom being shielded by a water screen. An interesting feature here is the stair step arrangement of the inclined furnace bottom, in the risers of which steam jets are placed by means of which the ash, in the form of dust, is blown to the ash pit from which it is removed by sluicing.

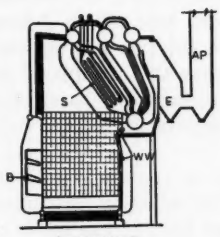
Springwells Pumping Station steam generating equipment is an example of a comparatively small boiler, 1000 hp., equipped with all modern heat absorbing surfaces, i.e., water walls, superheater, economizer and air preheater, which has resulted in the exceptionally low exit gas temperature of 245 deg. F. Another feature worthy of note is the cross-over arrangement of tubes entering the upper drums; by this design an entirely different circulation system is secured from the usual arrangement where all tubes from one bank enter the same drum. A somewhat different arrangement of tubes to secure improved circulation is employed in the boilers installed in the Longview Hospital plant; here, instead of crossing the tubes, the banks of tubes entering the upper drums are divided by baffles to give the three-pass arrangement and complete direct circulation paths between each of the first and second steam drums and the lower drum.

Boiler Designs

Two new boiler designs have made their appearance and are worthy of note as they are of particular service in modernizing plants where space limitation is a factor.

One of these is the two-drum water-tube design with water-cooled furnace especially suitable for firing with pulverized coal which was installed in the plant of the Caron Spinning Co. at Rochelle, Ill. It occupies the same space and uses the same supports as the hand fired h.r.t. boiler it replaced. It operates at modern high efficiency and increased the capacity of the plant several fold. The unit is complete in that it contains economizer, superheater, radiant and convection heating surface. The other design is known as the Burton boiler built in either two or three-drum design especially suitable for space with low head room. The principal heating surfaces consist, in the two-drum design, of loop bent water tubes, the straight portions lying nearly horizontal, and short, nearly vertical water tubes between the drums to maintain circulation. These boilers will find application in heating and industrial plants.

Need for increased capacity has led to slight changes in design of old installations with consequent saving to



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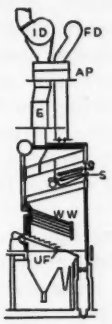

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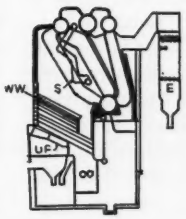
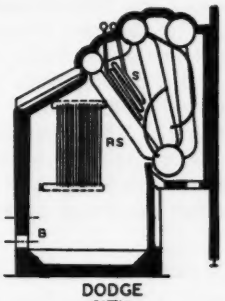
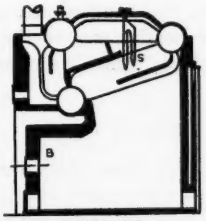


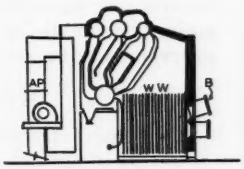
HOLLINGSWORTH AND WHITNEY



DODGE CITY

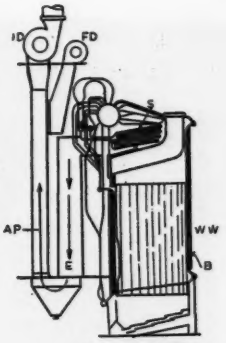


RADFORD



WEST FARGO

CLARIDGE HOTEL



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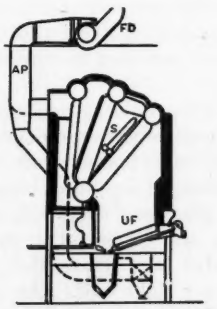
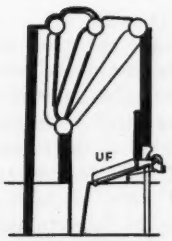
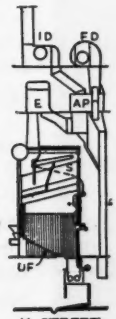


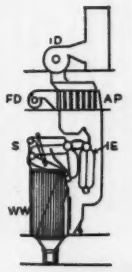
CHASE BRASS & COPPER



PILGRIM HOSPITAL

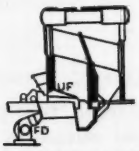


K STREET

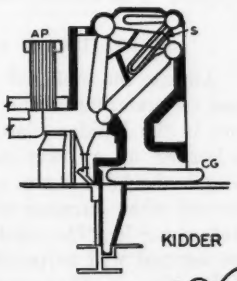


PENN. SUGAR CO.

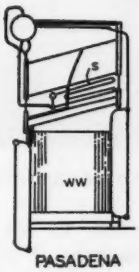
NOTRE DAME



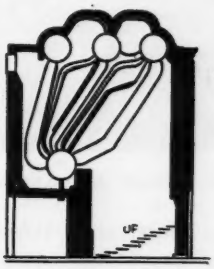
BRUNSWICK LAUNDRY



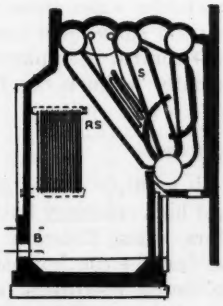
KIDDER



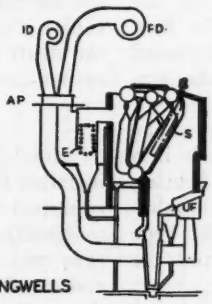
PASADENA



LONGVIEW HOSPITAL



CODY



SPRINGWELLS

LEGEND
WW-WATER WALL
AP-AIR PREHEATER
FD-FORCED DRAFT FAN
ID-INDUCED DRAFT FAN
E-ECONOMIZER
IE-INTEGRAL ECONOMIZER
B-BURNER
S-SUPERHEATER
UF-UNDERFEED STOKER
CG-CHAIN GRATE STOKER

BOILER CROSS SECTIONS OF TYPICAL INSTALLATIONS MADE IN 1932

DIAGRAMMATIC ONLY SKETCH SIZE NOT PROPORTIONAL TO RELATIVE SIZE OF UNITS

the plant owner. An example of this was the changing of horizontal water-tube boilers in a plant of the New York Steam Corp. from 3-pass to 2-pass and the installation of an economizer behind the bridge-wall with a consequent increase in capacity of 45 per cent.

One of the developments of the past year is a small self-contained oil-fired boiler built in capacities ranging from 15 to 125 b.hp., especially suitable for supplying process steam. It is of internal combustion, four-pass construction with completely automatic combustion control and flue gas temperature is reduced to 300 to 400 deg. F.

Changes in Superheater Arrangements

No radical changes have been made in superheater practice during the past year but some changes in the

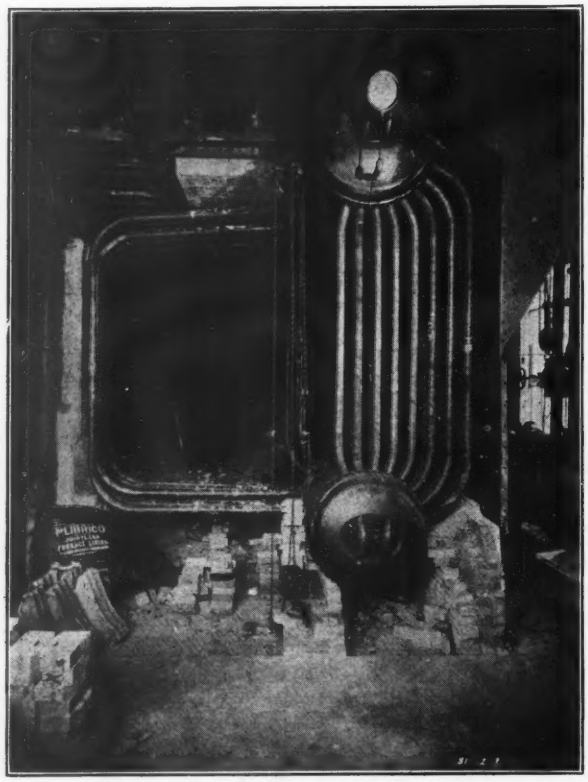


FIG. 1. BOILER AT CARON PLANT UNDER ERECTION

form and location of tubes are noted. In the Kidder Station, for example, a series arrangement of superheater tube banks is provided. Steam entering the superheated drum is baffled and compelled to flow through the two banks in series, the banks being placed in two different sections of the boiler where the surrounding temperatures are undoubtedly quite different. At Hollingsworth & Whitney plant an unusual W shape of superheater tubes is used which fits conveniently into the design of the boiler, gives some additional heating surface and allows for expansion. Only two plants tabulated this year employ both radiant and convection type superheater; these are the Dodge City plant and the Cody station.

An outstanding design of superheater arrangement is that for type W boilers at Trenton Channel which has for its purpose the delivery of steam at practically constant temperature. This arrangement consists of three sections, two of which are in semi-radiant positions in the first banks of boiler tubes; these operate in parallel and discharge their steam to the third section which is in a convection location in one side of the boiler. By manipulating the dampers on the two gas outlets from the boilers, it is possible to vary the amount of convection heat going to the third element of the superheater and thus control the total temperature of the delivered steam.

Among the developments in superheaters is a new design for application on h.r.t. boilers consisting of two headers, lying along the upper part of the boiler one on either side, connected by detachable tubular elements which pass around underneath the boiler. Steam passes from the boiler outlet to one header, through the superheater tubes to the other header and to the steam main. These units are of advantage where a modernizing program is being carried out.

Baffles and Lining

Although straight baffling or that following the curvature of the tubes is almost universally used, in the Dodge City and Cody boilers curved cross baffling has been worked out to give a three-pass arrangement in a four-drum bent-tube boiler with gas exit at the bottom. This arrangement has also permitted the building and boiler walls to be tied together resulting in considerable saving in space.

To take the place of refractory blocks one manufacturer has developed a water wall construction consisting of water tubes spaced in the usual manner but instead of being fitted with blocks clamped in place, iron studs are welded to the tubes and plastered over with refractory of suitable conductivity and thickness to give the desired rate of heat transfer and close the spaces between the tubes to make an air tight wall. Any desired portion of the wall, usually the upper part, may be left exposed to the radiant heat of the furnace and the tubes can be bent to any desired shape to fit the furnace design. Results from the use of this construction are reported to be entirely successful.

Lignite Burned at High Rate on Stoker

Among the stokered plants recorded this year, the most outstanding in the way of heat release in the furnace is the Kidder plant where the No. Dakota lignite is burned on a traveling grate and a maximum heat release of 64,000 B.t.u. per cu. ft. of furnace volume is secured when burning 85 lb. of fuel per sq. ft. of grate surface per hr. The conditions under which these results are secured will be published in a subsequent issue but suffice it to say that zone draft control is employed and the draft is so strong as actually to burn the fuel in suspension.

Ash Discharge

Heretofore, practically all multiple retort stokers installed for high capacity and high efficiency have been equipped with clinker grinders, whose function it was to discharge the ash from the furnace continuously and thus maintain uniform combustion conditions on the stoker. A new stoker which discharges the ash continuously without the use of a clinker grinder has been developed and placed in operation. The stoker employs a multiple retort underfeed section and a link grate

BOILERS AND COMBUSTION EQUIPMENT

STATION	NO.	TYPE	NO. PASSES	CAPACITY PER BOILER LB. PER HR. NORMAL	CAPACITY PER BOILER LB. PER HR. MAX.	ABSOLUTE PRESSURE LB PER SQ. IN.	TOTAL STEAM TEMP DEG. F.	HEATING SURFACE PER BLR. SQ. FT. BOILERS	WATER WALLS	SUPER-HEATER	ECON.	AIR PREHTR.	PULVERIZING MILLS TYPE	NO PER BOILER	CAPACITY T/PER HR EACH	DRIVE AND POWER CONSUMED KW-HR/TON	MAXIMUM AND MINIMUM FINENESS % THRU 200 MESH	PERCENT MOISTURE IN FUEL TO MILL.	BURNERS TYPE	NO. PER BOILER	AIR SUPPLY PRIMARY PERCENT OF TOTAL	AIR SUPPLY PRIMARY TEMP DEG. F.	AIR SUPPLY SECONDARY PERCENT OF TOTAL	AIR SUPPLY SECONDARY TEMP. DEG. F.	STOKERS TYPE	LB. COAL PER SQ. FT. PER HR. MAX.	RATIO TOTAL STEAM MAKING SURFACE TO SQ. FT. GRATE AREA	PROJECTED GRATE AREA SQ. FT.	DRIVE	NUMBER OF RETORTS UNDERFD.	NUMBER OF TUYERES UNDERFD.	CHAIN GRATE LENGTH-L. WIDTH-W IN FEET	NUMBER OF ZONES IN AIR SUPPLY
QUINDARO	2	4 DRUM BENT TUBE	3	150,000	180,000	425	700	16,267	1,955	5,704	1,843	19,500	TABLE	2	7-5	IND. MOT.	64-68	5-10	HORIZONTAL TURBULENT	4	30	150	70	350	NOT APPLICABLE									
K STREET	2	HORIZ. CROSS DRUM	3	100,000	140,000	605	725	10,500	727	——	3,780	18,080	NOT APPLICABLE												UNDERFEED	52.5	32.6	344	HYDRAUL.	11	41	——	2
HARDING ST.	8	HOR. CROSS DRUM	3	124,000	190,000	455	725	11,810	833	2,540	5,760	17,800	NOT APPLICABLE												UNDERFEED	64	36.28	348.61	VAR. SPEED A.C. MOTOR	10	45	——	——
CODY	2	BENT TUBE	3-CROSS BAFFLE	38,000	72,000	380	750	6,070	——	——	——	——	——	——	——	——	——	——	?	?	——	——	——	——	NOT APPLICABLE									
PASADENA	2	HOR. CROSS DRUM	3	150,000	210,000	415	750	15,186	946	3,340	NONE	37,000 REGENERAT. TYPE	——	——	——	——	——	——	HORIZ. COMBINED GAS & OIL	12	100	425	——	——	NOT APPLICABLE									
KIDDER	2	BENT TUBE 4 DRUM	3	24,000	78,000 PLUS	325	600	7,500	——	1,240	——	6,950	NOT APPLICABLE												TRAV'L. GRATES	85 PLUS	2.95	256	MOT. VAR. TRANS.	——	——	2-EACH 8' X 16'	6
DODGE CITY	2	BENT TUBE 4 DRUM	3	——	72,000	440	750	6,000	——	81.5 RAD. 922 CONV.	——	9,880	OIL & GAS BURNERS						HORIZ. COMBINATION	5	100	428	——	——	NOT APPLICABLE									
HOLLINGWTH AND WHITNEY	2	BENT TUBE 4 DRUM	3	100,000	150,000	455	580	11,210	669	——	8,400	——	NOT APPLICABLE												UNDERFEED	46	47.0	240	TURBINE	10	29	——	——
PHILIP CAREY	2	CROSS DRUM	1	120,000	150,000	1,840	800	4,696	2,815	——	5,930	30,168	TABLE	1	1-8	?	80	3.0	?	4	?	180	——	350	NOT APPLICABLE									
PURDUE UNIV.	2	BENT TUBE 4 DRUM	3	28,160	44,740	224.7	560	6448	279-5	960	——	——	NOT APPLICABLE												UNDERFEED	49.8	44.7	144.2	TURBINE	5	37	——	1
WEST FARGO	1	BENT TUBE 4 DRUM	3	50,000	60,000	PRESENT 180 LATER 250	373 411	8,150	923	——	——	7,350	TABLE	1	3	TURB. & MOTOR 8-2	64-82	4.2	HORIZ. TURBULENT	2	15-20	350	85-80	350	NOT APPLICABLE									
RADFORD	2	BENT TUBE 3 DRUM LOW HEAD	3	11,800	15,300	180	455	2160	——	?	——	——	IMPACT	1	1	D.C. MOT. 16	?	6.0	HOR. TURBULENT	1	25	160	75	160	NOT APPLICABLE									
PENNSYLVANIA SUGAR CO.	2	BENT TUBE 4 DRUM	2	250,000	300,000	415	525	11,000	6,530	435	5,000	18,750	AIR SWEPT BALL	4	5	TURBINE	——	1 TO 5	HOR. TURBULENT	4	?	?	?	?	NOT APPLICABLE									
CLARIDGE HOTEL	3	STRAIGHT TUBE CROSS DRUM	3	6,500	?	190	378	2,000	——	——	——	——	NOT APPLICABLE												HAND	?	?	?	MANUAL	——	——	——	——
PILGRIM HOSPITAL	4	BENT TUBE 4 DRUM	3	45,000	60,000	165	266	10,040	——	——	——	——	NOT APPLICABLE												UNDERFEED	41	83.5	164	ENGINE	7	33	——	——
LONGVIEW HOSPITAL	4	BENT TUBE 4 DRUM	3	9,900	24,750	265	406	3,000	——	——	——	——	NOT APPLICABLE												UNDERFEED	30	30	100	MOTOR	1	——	——	——
CHASE BRASS & COPPER CO.	3	BENT TUBE 4 DRUM	4	——	37,500	215	540	5,000	?	?	——	4,000	NOT APPLICABLE												UNDERFEED	?	?	?	MOTOR	5	?	——	——
BRUNSWICK LAUNDRY	4	STRAIGHT TUBE 2 DRUM	3	2-15,270 2-13,500	2-30,540 2-27,000	130	347	5,087 4,540	——	——	——	——	NOT APPLICABLE												UNDERFEED	?	?	?	MOTOR	2-6 2-5	?	——	——
SPRINGWELLS	2	BENT TUBE 4 DRUM	3	70,000	90,000	395	710	10,388	510	1,720	2,430	9,980	NOT APPLICABLE												UNDERFEED	58	53.4	190	D.C. MOT.	8	27	——	2
NOTRE DAME UNIVERSITY	4	HORIZ. CROSS DRUM	3	27,845	38,625	135	350.3	4,050	——	——	——	——	NOT APPLICABLE												CHAIN GRATE	35.6	42.2	96	INDIVIDUAL STEAM ENGINE	——	——	12'x 8'	5

—— NO EQUIPMENT INSTALLED OR NOT APPLICABLE ?-REQUIRED DATA NOT FURNISHED

FURNACES									
STATION	FUEL & METHOD OF FIRING	FURNACE VOLUME CU.FT. EACH	RATIO FURNACE VOLUME TO WATER BOILING SURFACE ▲	MAX. B.T.U. LIBERATED PER CU.FT. PER HR.	CORRESPOND OUTPUT IN 1000 LB. STM. PER HR.	WATERWALLS TYPE	WATERWALLS PERCENT OF TOTAL WATER BOILING SURFACE ●	TYPE FURNACE BOTTOM	METHOD OF ASH DISPOSAL
QUINDARO	SO. KANSAS BITUMINOUS PULVERIZED	10,900	0.60	23,800	180	PLAIN TUBES-WING BACK BLOCKS	10.7	SLAG TAP	SLUICE
K STREET	1 BLR.-KAN. COAL-STOKERS 1 BLR=NAT. GAS-OIL STANDBY	5,800	0.515	34,000	140	BOLTED BLOCK	6.47	REFRACTORY BOTTOM - AIR COOLED FOR GAS BOILER	SLUICE FOR STOKER FIRED BOILER
HARDING STREET	INDIANA BITUM. UNDERFEED STOKER	6,700	0.53	37,300	190	PLAIN TUBES; ARMOR CLAD-BLKS. CAST ON-CI.BLKS. BOLTED ON	6.58	STOKER	SLUICE
CODY	GAS & OIL	3,996	0.658	19,540	72	AIR COOLED FURNACES		?	——
PASADENA	OIL & NATURAL GAS	7,600	0.47	36,700 APPROX	210	PLAIN TUBE	5.86	FLAT — AIR COOLED	——
KIDDER	N.DAKOTA LIGNITE-STOKERS	2,200	0.296	64,000	78	NONE	——	——	SLUICE
DODGE CITY	OIL & GAS	5,545	0.924	18,900	72	——	——	FIRE BRICK	——
HOLLINGSWORTH & WHITNEY	W. VA. BITUMINOUS UNDERFEED STOKER	3,870	0.326	51,000	150	ARMORED AND WING-BACK BLOCKS	5.63	CLINKER GRINDER	SLUICE
PHILIP CAREY	W. VA. BITUMINOUS PULV.	9,700	1.29	20,600	180	FIN TUBES	37.5	CASCADED TILE	SLUICE
PURDUE UNIVERSITY	INDIANA SCREENINGS UNDERFEED STOKERS	2,687	0.40	23,054	43.5	PLAIN TUBES; ARMORED SIDE-WALLS & BRIDGEWALL	4.15	UNDERFEED CRUSHER ROLLS	CONVEYOR AND CAR
WEST FARGO	W. VA. SPLINT PULVERIZED	3,700	0.523	20,000	60	PLAIN TUBES	13.0	FLAT REFRACTORY	HOE THROUGH FRONT DOORS TO FIRING FLOOR
RADFORD	VA. OR W.VA. BITUMIN. PULVERIZED	1,372	0.636	15,750	15.3	AIR COOLED WALLS	——	FLAT AIR COOLED	MANUAL
PENNSYLVANIA SUGAR CO.	PULVERIZED COAL OIL	10,425	0.595	26,000	250	PLAIN TUBES	37.2	SCREW CONV.	SLUICE
CLARIDGE HOTEL	ANTHR. RICE — STOKERS	?	?	?	?	——	——	STOKER	ELEV. TO BUNKER AND TRUCKS
PILGRIM HOSPITAL	BITUMINOUS — STOKERS	4,400	0.438	18,000	60	——	——	STEAM ASH DUMP	INDUSTRIAL CARS
LONGVIEW	BITUMINOUS — STOKERS	1,000	0.333	36,000	20	——	——	STOKER	MANUAL
CHASE BRASS & COPPER CO.	BITUMINOUS-STOKERS	?	?	?	?	BRIDGEWALL	?	HYDRAULIC ASH DUMP	INDUSTRIAL CARS
BRUNSWICK LAUNDRY	BITUMINOUS-STOKER	1,140	0.225	?	?	——	——	STOKER	INDUSTRIAL CARS
SPRINGWELLS	W. VA. BITUMIN- STOKERS	4,125	0.397	29,127	90	PLAIN TUBES	4.68	CLINKER GRINDER	SLUICE
NOTRE DAME UNIVERSITY	INDIANA — BITUMIN. C.G. STOKERS	1,423	0.35	28,400	34.9	——	——	STOKER	INDUSTRIAL CARS & BUCKET CONVEYOR

—— NO EQUIPMENT INSTALLED OR NOT APPLICABLE. ?~REQUIRED DATA NOT FURNISHED ▲~FURNACE VOLUME DIVIDED BY THE SUM OF THE BOILER WATER HEATING SURFACE AND THE WATERWALL SURFACE. ●~WATERWALL SURFACE TIMES 100 DIVIDED BY THE SUM OF THE BOILER WATER HEATING SURFACE AND THE WATERWALL SURFACE.

overfeed section similar to those used in the clinker grinder installations.

Instead of discharging the ash into a clinker grinder pit, the stoker pushes the ash through an opening between a horizontal ash discharging plate and the lower corner of the rear wall of the furnace, which is water cooled to prevent the adhesion of the ash to it. This stoker in operation is reported to have produced results in both capacity and efficiency which are comparable to those produced by the clinker grinder stoker. Thus, equivalent results are produced at a considerable saving in the cost of the stoker installation as well as in a saving of headroom, amounting in the average case to from 6 to 8 ft.

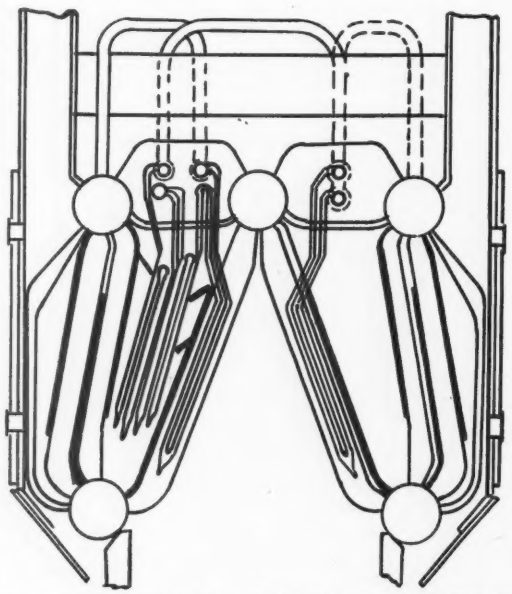


FIG. 2. SUPERHEATER ARRANGEMENT DESIGNED TO MAKE TEMPERATURE CONTROL POSSIBLE

Accomplishments with Pulverized Coal

What probably is a record heat release from one pulverized coal burner was accomplished in a new design of turbulent burner installed in the W. Va. Pulp and Paper Co. plant where the heat liberation rate per hour reached 205,000,000 B.t.u.

Quite an important accomplishment in the history of pulverized coal burning is that taking place in the plant of the Orenda Corp. at Wilmington, Ill., where local strip mine coal with 14 per cent moisture and low fusing temperature ash is being pulverized and burned to secure a heat release as high as 13,400 B.t.u. per cu. ft. of furnace volume. The secret of the success lies, it is reported, in the combination of a large air cooled furnace which provides highly preheated air to the mill and a pulverizer through which all the air required for combustion can be drawn to assure sufficient drying effect to handle the high moisture content without condensation or sticking.

Burning petroleum coke in pulverized form has been the subject of investigation at the Michigan City plant, the detailed results of which will be given in a future issue. It may be stated here, however, that, as compared to coal, increased fineness was necessary, 85 per cent through 200 mesh screen, some advantages being 30 per cent increase in boiler capacity, less deposit on heating surfaces, less ash and nearly 4.5 per cent increase in efficiency of the boiler.

During the year some application of electrical interlocking to mechanical draft equipment has been made that has proved admirably successful in the operation of boiler plants. In this system, as installed at the West Fargo plant, the induced draft fan, forced draft fan, pulverizer exhaust fan and pulverizer mill are started in the sequence named to insure against mechanical

FANS, ECONOMIZERS AND AIR PREHEATERS

FANS

STATION	FORCED DRAFT TYPE	NO. PER BLR.	CAP. EACH C.F.M.	CAP. TOTAL C.F.M.	DRIVE	STATIC PRESS. IN. H_2O	INDUCED DRAFT TYPE	NO. PER BLR.	CAP. EACH C.F.M.	CAP. TOTAL C.F.M.	DRIVE	STATIC PRESS. IN. H_2O	BOILERS PER CHIMNEY
QUINDARO	BACKWARD CURVED	1	61,600	——	DUAL A.C. MOTOR	10.5	STEEL PLATE	1	116,000	——	DUAL A.C. MOTOR	7.5	2
K STREET	STEEL PLATE	1	56,000	——	VAR.SP.SLIP RING MOTOR	9.1	STEEL PLATE	1	80,000	——	VAR.SPD.SLIP RING MOTOR	9.4	1
HARDING STREET	FORWARD CURVED	1	66,000	——	DUAL A.C. MOTOR	6.9	FORWARD CURVED	1	112,800	——	DUAL A.C. MOTOR	8.9	1
CODY	BACKWARD CURVED	1	11,000	——	A.C.MOTOR	0.875	——	&	——	——	——	——	?
PASADENA	BACKWARD CURVED	1	60,000	——	2 A.C. MOTORS	9.13	FORWARD CURVED	1	95,000	——	2 A.C. MOTORS	6.75	1
KIDDER	STEEL PLATE	1	40,500	——	VARIABLE A.C.MOTOR	8	FORWARD CURVED	1	68,000	——	VARIABLE A.C.MOTOR	8	1
DODGE CITY	BACKWARD CURVED	1	22,000	——	2 SPEED SQ. CAGE	4	RADIAL TIP	1	42,000	——	2 SPEED SQ.CAGE	8	2
HOLLINGSWORTH & WHITNEY	FORWARD CURVED	1	49,000	——	TURBINE	6	FORWARD CURVED	1	104,000	——	SLIP-RING MOTOR	11.5	2
PHILIP CAREY	FORWARD CURVED	1	50,000	——	VAR. SPEED A.C. MOTOR	7.75	FORWARD CURVED	1	100,000	——	VAR. SPEED A.C.MOTOR	10.25	1
PURDUE UNIVERSITY	FORWARD CURVED	1/2	64,000	——	STEAM TURBINE	7	——	——	——	——	——	——	6
WEST FARGO	FORWARD CURVED	1	30,000	——	SINGLE A.C. 2 SR. MOTOR	6.5	FORWARD CURVED	1	30,000	——	A.C.MOTOR 2 SPEED	3.8	1
RADFORD	——	——	——	——	——	——	——	——	——	——	——	——	?
PENNSYLVANIA SUGAR CO.	BACKWARD CURVED	1	108,000	——	TURBINE	12	RADIAL TIP	1	200,000	——	TURBINE	12	1
CLARIDGE HOTEL	FORWARD CURVED	1/3	?	?	DUAL—MOT. & ENGINE	?	——	——	——	——	——	——	3
PILGRIM HOSPITAL	FORWARD CURVED	1/2	?	?	ENGINE	?	——	——	——	——	——	——	?
LONGVIEW HOSPITAL	FORWARD CURVED	1	?	?	MOTOR	?	——	——	——	——	——	——	4
CHASE BRASS & COPPER CO.	BACKWARD CURVED	1	18,400	——	TURBINE	3.24	FORWARD CURVED	1	33,000	——	TURBINE	1.3	1
BRUNSWICK LAUNDRY	FORWARD CURVED	1	2—16,000 2—14,000	——	MOTOR	5.5	——	——	——	——	——	——	4
SPRINGWELLS	DOUBLE INLET RADIAL FLOW	1	45,000	——	D.C.MOTOR	13.5	STEEL PLATE	1	75,000	——	D.C.MOTOR	11.0	2
NOTRE DAME UNIVERSITY	BACKWARD CURVED	1	15 000	——	DUAL-ST.TURB. & A.C.MOTOR	4	——	——	——	——	——	——	4

ECONOMIZERS

STATION	LOCATION	WATER TEMPERATURE IN	WATER TEMPERATURE OUT	GAS TEMPERATURE IN	GAS TEMPERATURE OUT
QUINDARO	BEHIND BOILERS	225	275	765	637
K STREET	ABOVE BOILERS	213	300	STOKER 640 GAS FIRED 410	FIRED BLR. 380
HARDING STREET	ABOVE BOILERS	290	388	835	561
CODY	——	——	——	——	——
PASADENA	——	——	——	——	——
KIDDER	——	——	——	——	——
DODGE CITY	——	——	——	——	——
HOLLINGSWORTH & WHITNEY	——	——	——	——	——
PHILIP CAREY	BEHIND BOILERS	270	420	950	450
PURDUE UNIVERSITY	——	——	——	——	——
WEST FARGO	——	——	——	——	——
RADFORD	——	——	——	——	——
PENNSYLVANIA SUGAR CO.	FRONT OF BOILERS	?	?	?	?
CLARIDGE HOTEL	——	——	——	——	——
PILGRIM HOSPITAL	——	——	——	——	——
LONGVIEW HOSPITAL	——	——	——	——	——
CHASE BRASS & COPPER CO.	——	——	——	——	——
BRUNSWICK LAUNDRY	——	——	——	——	——
SPRINGWELLS	BEHIND BOILER	220	288	665	466
NOTRE DAME UNIVERSITY	——	——	——	——	——

AIR PREHEATERS

STATION	TYPE OF AIR PREHEATER	CAPACITY LB. AIR PER HR. TOTAL	AIR TEMPERATURE IN	AIR TEMPERATURE OUT	GAS TEMPERATURE IN	GAS TEMPERATURE OUT
QUINDARO	PLATE	205,500	80	426	634	372
K STREET	ROTARY ELEMENT	170,000 PER UNIT	100	300	STOKER —— GAS FIRED 380	FIRED B. 225 BLR. 260
HARDING STREET	REGENERATIVE	287,000	80	325	581	328
CODY	&	——	——	——	——	——
PASADENA	ROTARY ELEMENT	219,000	100	500	700	322
KIDDER	TUBULAR	?	90	390	570	300
DODGE CITY	REGENERATIVE	72,000	100	518	700	428
HOLLINGSWORTH & WHITNEY	——	——	——	——	——	——
PHILIP CAREY	TUBULAR	?	70	350	480	250
PURDUE UNIVERSITY	——	——	——	——	——	——
WEST FARGO	TUBE	89,400	85	360	480	290
RADFORD	——	——	——	——	——	——
PENNSYLVANIA SUGAR CO.	TUBULAR	?	?	?	?	?
CLARIDGE HOTEL	——	——	——	——	——	——
PILGRIM HOSPITAL	——	——	——	——	——	——
LONGVIEW HOSPITAL	——	——	——	——	——	——
CHASE BRASS & COPPER CO.	PLATE	18,400	80	300	?	?
BRUNSWICK LAUNDRY	——	——	——	——	——	——
SPRINGWELLS	ROTARY ELEMENT	92,500	70	312	470	245
NOTRE DAME UNIVERSITY	——	——	——	——	——	——

—— NO EQUIPMENT INSTALLED OR NOT APPLICABLE. ? REQUIRED INFORMATION NOT FURNISHED. & NO INDUCED DRAFT FANS OR AIR PREHEATERS AT PRESENT BUT EXPECT TO INSTALL WITH SECOND UNIT.

FUEL STORAGE AND HANDLING

STATION	FUEL TYPE	FUEL B.T.U. CONTENT	AVERAGE OUTSIDE STORAGE TONS FUEL OIL-GAL.	MAXIMUM DEPTH OF STORAGE PILE	UNLOADING EQUIPMENT	STORAGE AND RECLAIMING EQUIP.	PREPARATION FOR BURNING	CONVEYORS TO BOILER HOUSE BUNKERS	BLR. HOUSE BUNKERS CAPACITY T.	HOW IS FUEL WEIGHED OR MEASURED
QUINDARO	SO. KANSAS BITUMINOUS	12,000	9,000	20 FT.	TRACK HOPPER	LOCOMOTIVE CRANE	RING CRUSHER	BELT	230 T/BLR.	AUTO. SCALES AHEAD OF PULV. FEEDER
K STREET	KANSAS COAL NATURAL GAS OIL	11,000 1,000 B.T.U. PER CU.FT. GAS	10,000 T.	15 FT.	TRACK HOPPER LOCOMOTIVE CRANE	LOCOMOTIVE CRANE	BREAKER	BELT	504 T.	WEIGH LARRY
HARDING STREET	IND. BITUMINOUS	11,250	24,000	15 FT.	TRACK HOPPER	BRIDGE CRANE	RING CRUSHER	BELT	325T/BLR	AUTO. SCALES AHEAD OF STOKERS
CODY	GAS & OIL	GAS — 950 OIL — 18,500	46,200	——	——	——	——	——	——	?
PASADENA	GAS OIL	1,000 - 1,200 18,000 - 19,000	—— 3,380,000	—— ——	—— DUMP PITS AND PUMPS	—— ——	—— STEAM HEATERS	PIPE LINE PIPE LINE	—— 350 BBL. SERV TANK	ORIFICE METER PISTON TYPE DISPLACEMENT MTR
KIDDER	N.DAKOTA LIGNITE	6,500	STORAGE IN CARS 6-8T.	——	TRACK HOPPER	——	CRUSHER	V-BUCKET	140	TRAVELLING LARRY
DODGE CITY	NAT. GAS OIL	1,035 ——	—— 420,000	—— ——	—— PUMPS	—— ——	—— ——	—— ——	—— ——	GAS METERS OIL METERS
HOLLINGSWORTH & WHITNEY CO.	W.VA. BITUMINOUS	14,600	?	?	TRACK HOPPER	LOCOMOTIVE CRANE	CRUSHER	BELT	125 T./BLR.	WEIGHTOMETER IS AHEAD OF BUNKERS
PHILIP CAREY	W.VA. BITUMINOUS	13,800	1,000	12	TRACK HOPPER	CLAMSHELL CRANE	RING CRUSHER	BUCKET CONVEYOR	500	MOVABLE HOPPER SCALES
PURDUE UNIVERSITY	INDIANA SCREENING BITUMINOUS	11,780	6,500	20	TRACK HOPPER	LOCOMOTIVE CRANE	CRUSHER	APRON CONV., BUCKET ELEV., FLIGHT CONV.	275	WEIGH LARRY
WEST FARGO	W. VA. SPLINT SCREENINGS	12,512	200	—	TRACK HOPPER	——	——	SCREW CONVEYOR & BUCKET ELEVATOR	50	CARLOAD DELIVERIES
RADFORD	VA. OR W.VA. BITUMINOUS	14,200	200	—	CARS DUMPED FROM TRESTLE	——	——	——	——	TRACK SCALE
PENNSYLVANIA SUGAR CO.	PA. BITUMINOUS OIL	COAL 12,000 - TO 14,500 ——	3,000 26,000	20 ——	TRACK HOPPER & CRANE FROM BARGE ——	LOCOMOTIVE CRANE ——	CRUSHER & PULVERIZER	BELT ——	75 ——	AUTO. SCALE AHEAD OF PULV. FEEDER ——
CLARIDGE HOTEL	ANTHRACITE RICE	?	——	——	TRUCKS DUMP TO STORAGE	MANUAL	——	ELEVATOR—FUTURE	——	TRUCKLOAD DELIVERIES
PILGRIM HOSPITAL	EASTERN BITUMINOUS	12,000 TO 14,000	?	?	TRACK HOPPER & APRON CONVEYOR	?	CRUSHER	BUCKET ELEVATOR & FLIGHT CONVEYOR	400	TRAVELLING WEIGH LARRY
LONGVIEW HOSPITAL	BITUMINOUS OHIO	12000	——	——	MANUAL	MANUAL	——	——	——	——
CHASE BRASS & COPPER CO.	BITUMINOUS	?	424	?	TRACK HOPPER LOCO. CRANE	LOCOMOTIVE CRANE	CRUSHER	BELT CONVEYOR BUCKET ELEVATOR	300	AUTO SCALES
BRUNSWICK LAUNDRY	BITUMINOUS	?	——	——	HOPPER	——	CRUSHER	BUCKET ELEVATOR	150	WEIGH LARRY
SPRINGWELLS	W.VA. BITUMINOUS	13 500	18 000	25	TRACK HOPPER	DRAG SCRAPER	CRUSHER	BUCKET ELEV. & BELT	400T/BLR.	AUTO. SCALES AHEAD OF STOKERS
NOTRE DAME UNIVERSITY	IND. BITUMINOUS	11000	1 200	9	TRACK HOPPER	DRAG SCRAPER	CRUSHER	BUCKET CONVEYOR	750	WEIGH LARRY

— NO EQUIPMENT INSTALLED OR NOT APPLICABLE ? REQUIRED DATA NOT FURNISHED

injury to the equipment and to insure safety in starting. The combustion control is fully automatic once the boiler is put into operation, a process which is assured of proper sequence by the interlocking system. At the Waukegan Station of the Public Service Co. of No. Ill. a more elaborate interlocking system is employed which extends over the coal feeding system in addition to the fan equipment.

Of recent years many plants have been built where the heating elements and draft equipment were strung out vertically, an arrangement of which Harding Street, Pennsylvania Sugar and K Street stations are notable examples in this year's developments. A more conservative horizontal arrangement seems to characterize the plants of today and placing the draft equipment and less active heating surfaces in the basement, as worked out in the Dodge City and Cody plants, has advantages in reducing structure and duct costs.

A Boiler Room with No Bunkers

Coal handling at Huntley No. 2 Station is the most unusual arrangement reported this year. Here no inside

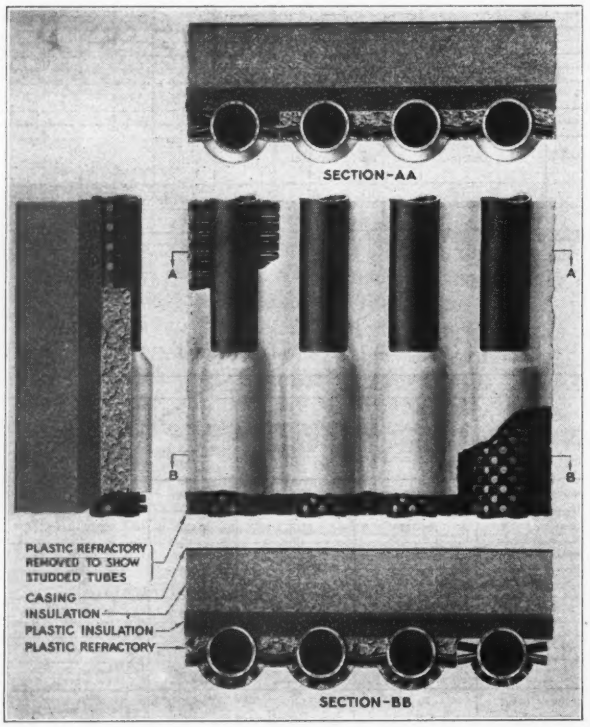


FIG. 3. NEW STUB TUBE FURNACE WALL CONSTRUCTION

coal storage or bunkers are provided. From outside storage, coal is fed by gravity through the coal crusher to an extended scale belt, discharging to feeders built as part of the pulverizer. Each boiler is provided with two mills and six burners, three in each of two opposite walls. Automatic oil ignition is provided for each burner.

At Waukegan an automatic kick back car dumping system was put into operation and has features that may spread in use at plants using large quantities of coal. For the first time, alternating current motors and controls are used here throughout the system. Car pullers draw the cars to a mule-haul which runs on a narrow-gage track laid inside the standard gage track; the mule-haul spots the car over the pit where the car is rotated through 180 deg. to discharge its contents when it is reversed and pushed off the pit by a succeeding loaded car, down an incline to a kick-back that reverses its motion and, by means of a photo electric relay, it is switched to a side track as it comes off the switch-back. The entire system is operated by one man.

Effect of Grain on Creep Characteristic

By C. L. Clark and A. E. White*

WHILE THERE ARE a large number of factors which may influence the actual or observed creep characteristics of metallic materials, those which are believed to be of the greatest importance are: chemical composition, heat treatment, recrystallization temperature, grain size, method of manufacture and testing procedure. Many of these factors are overlapping and it is difficult to consider one without one or more of the others. This is especially true of recrystallization temperature and chemical composition and, to a somewhat lesser extent, of grain size and heat treatment. Many claim that a metal's ability to recrystallize is merely a matter of time and, provided sufficient time is allowed, recrystallization will take place at any temperature.

The authors are of the opinion that the recrystallization temperature of a metal is one of the outstanding factors in determining the metal's creep characteristic. All metallurgists realize that every metal has a recrystallization temperature and usually this temperature of a given metal is different from that of any other metal and is affected by a large number of factors. It is affected by the deformation, size of grains prior to the deformation, purity of the metal and length of time at heat.

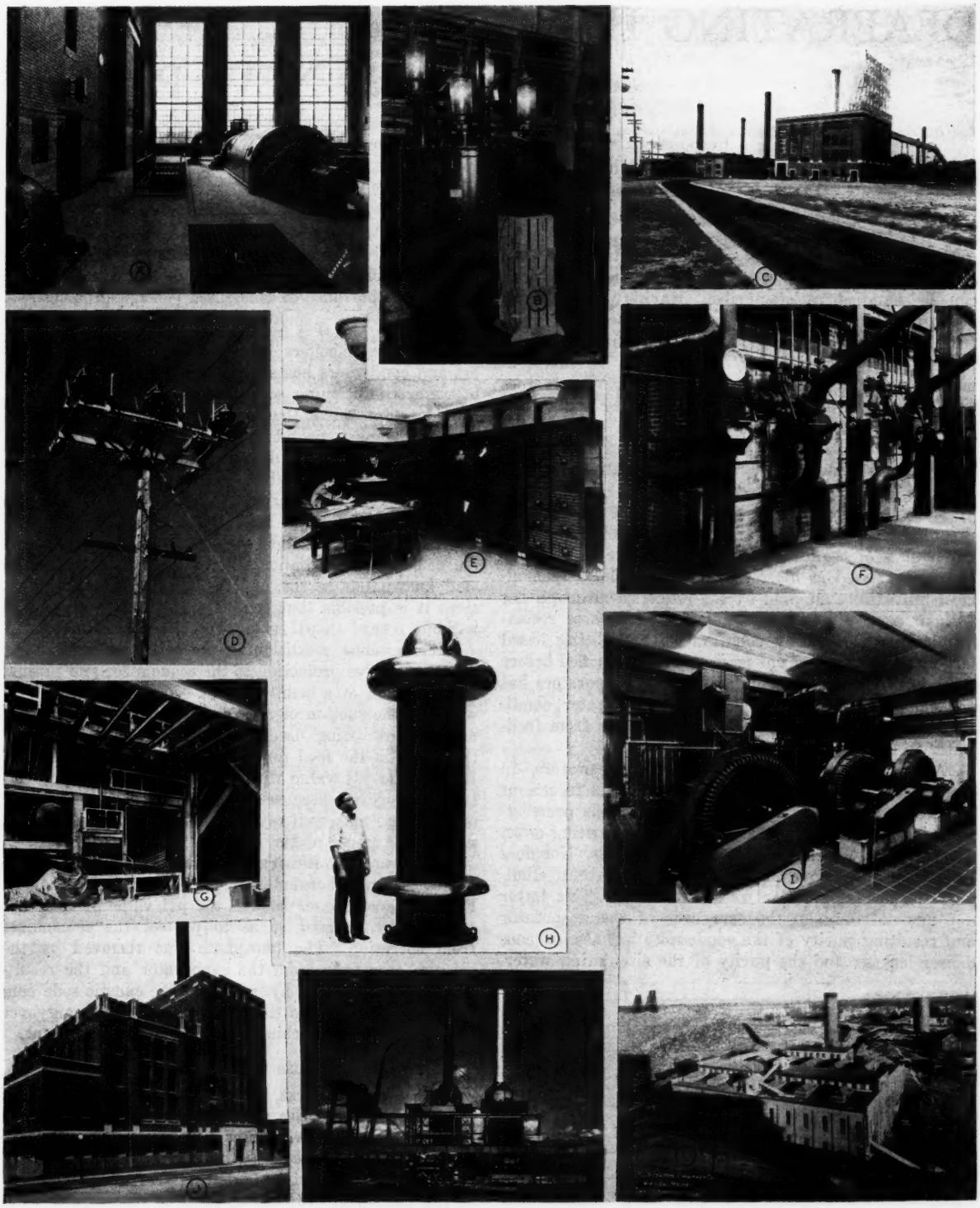
We always believed that as long as a metal was subjected to stresses below a certain fixed maximum at temperatures below the lowest recrystallization temperature, sufficient strain hardening would occur to stop any noticeable creep or continuous deformation and likewise if the temperature considered was above the lowest recrystallization temperature, then continuous measurable deformation would occur under practically any stress regardless of its magnitude. Results of tests lend support to this hypothesis.

Many conflicting statements have been made regarding the effect of grain size upon a metal's high-temperature strength characteristics and very few experimental data have been offered to support these statements. Purely from a theoretical viewpoint, grain size should play an important part in a metal's creep characteristics.

As the temperature is increased, however, the material surrounding the grains or the grain boundaries weakens at a more rapid rate than the crystals and a temperature is soon reached at which fracture proceeds around, rather than through the grains.

While the conclusions made are limited to the alloys which were considered, they are believed to be applicable to metals and alloys in general.

*Both from the University of Michigan, Ann Arbor, Mich. Taken from the paper presented before the 35th annual meeting of the A.S.T.M.



POWER DEVELOPMENT DURING 1932

A. The turbine room at Quindaro station. B. Transformer with rectifying tubes mounted on top, supplying high voltage D.C. to precipitator equipment (Westinghouse photo). C. Quindaro Station. D. Flashover protectors mounted on pole (Westinghouse photo). E. New short circuit calculating board at Commonwealth Edison Co. F. Boiler room at the Radford Plant. G. Springwells boiler room under construction. H. 700,000 v. X-ray transformer (General Electric photo). I. Engine room at Claridge Hotel. J. "K" Street Station at Lincoln. K. New mercury vapor plant at Schenectady (G. E. photo). L. Hollingsworth & Whitney plant.

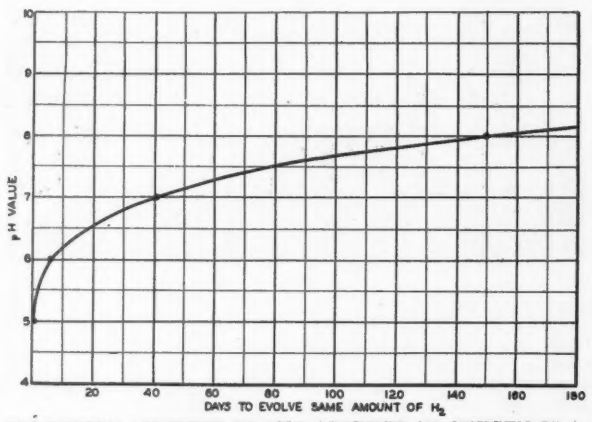
DEAERATING HEATERS *Universal in* NEW PLANTS

Evaporators, with and without pretreatment of water, widely used in Central Stations but Hot Processes and Zeolite systems are favored by Industrial Plants.

PRACTICALLY, the art of feedwater treatment has advanced to the point where all usual conditions can be handled satisfactorily. Having reached this point, the subject is being investigated more thoroughly from a theoretical standpoint for the purpose of improving the methods and reducing costs. In this connection a comprehensive coöperative effort by operators and manufacturers is already under way and when this work is completed it is expected that many of the doubtful or questionable data on solubilities of different chemicals in boiler water and their relation to each other will be definitely placed.

More important from an immediate standpoint, Straub's work on embrittlement will be checked. The importance of Straub's work is invaluable and cannot be overestimated as his recommendations have been almost universally adopted by the industry, although not without some opposition. Many feel that these recommendations are unduly conservative and, being based largely on the work of one man, should be verified before receiving such wide acceptance. Use of evaporators has not changed the relative importance of water conditioning although it has shifted the emphasis from feedwater to boiler water.

All central stations make use of evaporators, in many cases finding it advisable to use some treatment of the evaporator feed. The purpose of this pretreatment is to increase evaporator capacity by cutting down carryover or to facilitate cleaning of the coils. Nor does the use of the evaporator for suppying makeup eliminate the need for boiler water treatment. This latter depends not only on the carryover of the evaporator and resulting purity of the condensate but also on condenser leakage and the purity of the circulating water.



CORROSION ACTIVITY IN THE ABSENCE OF OXYGEN IS A FUNCTION OF THE pH VALUE. THIS CORROSION STOPS AT pH 9.6

Better packing methods, rolled tubes, better tube materials and construction have done much in recent years to lessen importance of condenser leakage problems.

pH and Corrosion

Corrosion of boilers, economizers, superheaters, heaters and condensers has always been an important phase of water conditioning so that perhaps the most important development of the year has been a better realization of the part played by the pH value of the boiler water in corrosion problems.[1] As shown by the accompanying curve of laboratory results, corrosion in the absence of oxygen increases rapidly as the pH value is lowered, i.e., the water made more acid. As shown by the universal use of deaerating heaters in this year's list of stations, the importance of oxygen elimination is well known but in the light of more recent investigations it is possible that complete elimination of oxygen without regard to pH value water is overestimated.

For instance, conditioning the boiler water does not necessarily give protection to the economizer and piping. Recirculation of a small amount of concentrated boiler water to the suction of the feed pumps is one practical method now being used to increase the pH value of the water in the feed pump line and in the economizer. Raising the pH value with chemicals requires close attenton, however, because the addition of chemicals for one purpose may well result in an undesirable effect on some other phase of the problem.

This was well illustrated by one large plant which uses trisodium phosphate for embrittlement prevention. Fed in the condenser hotwell the pH value of the feedwater was increased so as to protect the economizer from corrosion. The phosphate was removed by the calcium carryover from the evaporator and the resulting sodium carbonate hydrolyzed. The caustic soda concentration built up to the point where boiler carryover resulted, reducing turbine capacity about 15 per cent.

Evaporators for Makeup Water

The above remarks, of course, refer primarily to central station practice where the makeup is small. In industrial plants having moderate pressures and large makeup the hot process softener remains the favorite, although two industrial plants this year are making use of the industrial evaporator, or heat transformer as it is sometimes called, to insure pure feedwater. These two plants are Philip Carey and Chase Brass.

In this system industrial process steam which is not returned as condensate is supplied by evaporators, the steam and condensate from the evaporator coils remaining in a closed system with the boiler. Makeup require-

[1]See Placing pH in Corrosion and Water Treatment by S. E. Tray, Power Plant Engineering, June 15, 1932, p. 487.

ments for the boiler system usually consist of evaporator vapor condensed in an auxiliary heat exchanger.

This is not always the arrangement used, however, and at the Chase Brass plant the makeup due to power plant losses is taken care of by varying the proportion of evaporator vapor and steam through the reducing valve. Normally the evaporator output will correspond to the process requirements from which there are no returns, steam to the heating system being supplied through the reducing valve and returned to the storage hotwell as condensate. This condensate combining with the evaporator drains makes the boiler feed supply.

At Quintaro Station a somewhat similar situation was encountered except that instead of process work an older 175 lb. plant sometimes takes a considerable portion of steam from the new station. Makeup is supplied by two evaporators as shown by the heat balance, one supplying the new station losses, the other supplying 175 lb. superheated steam to the old plant. The arrangement for obtaining superheated steam from the evaporator is that high pressure steam to the evaporator flows through a heat exchanger counter current to the evaporator vapor.

At the Carey plant still another arrangement is used for supplying plant makeup. Condensate returns from the plant are pumped to a makeup storage tank as required to maintain a definite level, the balance of the returns going to the evaporator feed system. Makeup from the storage tank is introduced into the boiler system between deaerating heater and feed pump.

It must be remembered that the use of evaporators does not insure a pure feedwater supply as there is always the possibility of carryover and in industrial plants, the possibility of condensate contamination throughout the process or heating system. The evaporator offers a possible solution of the feedwater problem under certain conditions and is becoming of increased importance but it is not a panacea for all boiler ills.

Final feedwater temperatures range, as in previous years, around 375 to 400 deg. F., the highest final temperature being in the plants using economizers. At Harding Street water goes to the economizers at 290 deg. F. and at the Philip Carey plant 270 deg. F. Thus increasing plant flexibility and reconciling requirements of extraction heaters and economizers.

FEEDWATER TREATMENT & HEATING

STATION	TREATMENT: SOURCE OF MAKE-UP	TREATMENT: CHEMICAL SYSTEM	EVAPORATORS: EFFECTS	EVAPORATORS: STEAM PRESSURE TO FIRST EFFECT LB. ABS.	EVAPORATORS: CAPACITY LB. PER HR.	WATER HEATING TEMPERATURE DEG. F.																								FINAL FEED TEMP. DEG. F.
						EJECTOR		OIL COOLER		GEN. AIR COOLER		DEAER. HEATER		EVAP. CONDENSER		EXTRACTION HEATERS NO.1		NO.2		NO.3		NO.4		ECON.		
						IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	
QUINDARO	FILTERED RIVER	INTERNAL BOILER	1	65	7000	89	90.9	—	—	—	—	173	225	—	—	91	173.1	—	—	—	—	—	—	225	275	275
K STREET	CITY	HOT PROCESS	—	—	—	—	—	—	—	—	—	180	213	—	—	101	166	—	—	—	—	—	—	213	300	300
HARDING ST.	WELLS	HOT PROCESS AHEAD OF EVAP. & INTERNAL BLR TREATMENT	2	70	11500	90	92	—	—	—	—	170	217	153	170	92	153	217	290	—	—	—	—	290	388	388
CODY	WELLS	NONE	1	40	1300	101	111	—	—	—	—	189	227	—	—	111	198	227	328	—	—	—	—	—	—	328
PASADENA	WELLS	ZEOLITE	1	256	6000	101	103	89	91	74	78	—	—	228	316	103	166	166	226	226	316	316	388	—	—	388
KIDDER	RIVER	NONE	2	315	9400	83	88	—	—	—	—	90	210	210	232	—NO EXTRACTION 3000 KW. UNIT—								—	—	232
																232	SEE HEAT BALANCE FOR 7500KW					322		—	—	322
DODGE CITY	WELLS	NONE	1	47	3000	76	82	—	—	—	—	182	227	82	182	82	182	227	328	—	—	—	—	—	—	328
HOLLINGSWORTH AND WHITNEY	RIVER	SODA ASH & SODIUM PHOSPHATE	—	—	—	—	—	—	—	—	—	?	230	—	—	—	—	—	—	—	—	—	—	230	345	345
PHILLIP CAREY	WELLS	HOT PROCESS LIME & SODA	1	USED FOR PROCESS 45	150,000	—	—	—	—	—	—	▲ 225	▲ 240	240	270	—	—	—	—	—	—	—	—	270	420	420
PURDUE	WELLS	—	—	—	—	—	—	—	—	—	—	?	?	—	—	—	—	—	—	—	—	—	—	—	—	220
WEST FARGO	RIVER	INTERNAL BOILER	—	—	—	—	—	—	—	—	—	?	210	—	—	—	—	—	—	—	—	—	—	—	—	210
RADFORD	—	—	—	—	—	—	—	—	—	—	—	?	210	—	—	—	—	—	—	—	—	—	—	—	—	210
PENNSYLVANIA SUGAR CO.	RIVER	HOT PROCESS	—	—	—	—	—	—	—	—	—	?	?	—	—	—	—	—	—	—	—	—	—	—	—	240
CLARIDGE HOTEL	WELL	—	—	—	—	—	—	—	—	—	—	?	208	—	—	—	—	—	—	—	—	—	—	—	—	208
PILGRIM HOSPITAL	WELLS	—	—	—	—	—	—	—	—	—	—	?	210	—	—	—	—	—	—	—	—	—	—	—	—	210
LONGVIEW HOSPITAL	CITY	HOT PROCESS	—	—	—	—	—	—	—	—	—	?	210	—	—	—	—	—	—	—	—	—	—	—	—	210
CHASE BRASS & COPPER CO.	CITY	—	—	USED FOR PROCESS 215	20000	—	—	—	—	—	—	—	—	CLOSED HTR ?	215	—	—	—	—	—	—	—	—	—	—	215
BRUNSWICK LAUNDRY	CITY	—	—	—	—	—	—	—	—	—	—	?	210	—	—	—	—	—	—	—	—	—	—	—	—	210
SPRINGWELLS PUMPING STATION	LAKE	—	1	43	1500	88	92	—	—	—	—	92 HOT HEAT EXCH.	121 DRIP	121	195	121	195	195	267	—	—	—	—	220	288	288
NOTRE DAME	LAKE	ZEOLITE	—	—	—	—	—	—	—	—	—	130	220	—	—	—	—	—	—	—	—	—	—	—	—	213

▲ CLOSED HEATER USING 60 LB. EXHAUST STEAM

PRIME MOVERS *Show Change from* PAST PRACTICE

Engines used in many industrial plants suggest that heat balance demands may be met by combinations of simple equipment in preference to complicated bleeder turbines.

FOR THE FIRST TIME in many years no new or startling turbine developments are represented by central stations completed this year. There is, however, some prospect for developments in stations scheduled for completion next year so that progress in this direction has not stopped. Reheat turbines for Port Washington and State Line are under construction and may go into service next year, while the 160,000-kw. unit for Richmond Station will mean a material increase in the areas served by machines of 100,000 kw. and over.

Port Washington (80,000-kw.) and State Line (125-000-kw.) turbines are interesting not only because they are designed for 850 deg. F. steam temperatures but also because of the high pressure cylinder construction. These units will be tandem compound units with the steam to and from the reheater taken out of and returned at about the middle of the high pressure element. Both units are designed to operate at 1200 lb. throttle pressure, 850 deg. F.

850 Deg. F. Operation Satisfactory

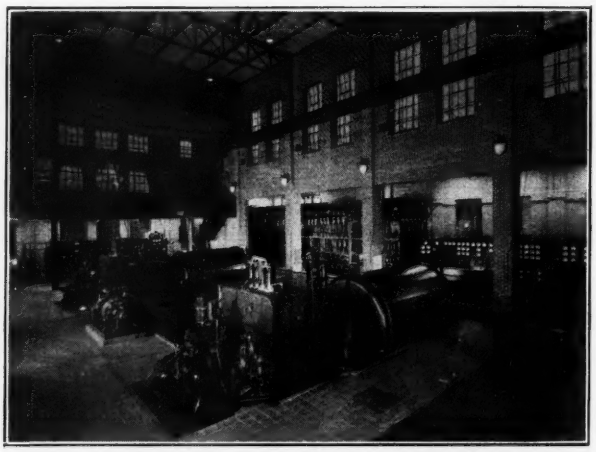
Operation at 825 deg. F. apparently presents no difficulty over the old 750 deg. F. standard as more than a year's operation of Edgewater, Burlington and Bremo Stations have indicated. The new addition to Bennings Station will also use 825 deg. (600 lb.) steam in a 35,000 kw. unit. This higher temperature may be considered as the new standard temperature for new construction of the better type, although it is questionable if it will long hold this position. Three recent oil fires, two in this country and one in Europe, have indicated the necessity for more care in oil line installation with high temperature steam lines and chests.

The Burlington unit is an excellent example of modernization. There an 18,000-kw., 650 lb., 850 deg. F. unit (the largest 3600 r.p.m. machine yet built) was superimposed on three 12,500-kw., 190 lb., 150 deg. F. superheat turbines. The old and new machines were thus combined to form a four cylinder compound unit of 55,000-kw. with a 30 per cent reduction in station heat rate, i.e., from 24,000 to 15,000 B.t.u. per kw-hr. Any machine can be operated independently or the high pressure unit can be used in combination with one, two or three of the old units as the load may require. The 75,000-kw. single cylinder unit installed by the same company in the Kearney Station is also an interesting unit (over a 65,000-sq. ft. welded shell condenser) as are the two 160,000-kw. single shaft units installed in Hudson Ave. Station and covered in last year's review.

Under the constant demand for higher temperatures, special alloys are constantly being developed. Unfortunately they are high in price and no short time testing methods have as yet been developed upon which to base predictions. The 1000 deg. F. turbine at Delray has been operating over a year at full temperature and is being closely studied. When completed these investigations will do much to shape future progress in the high temperature field.

Standardized Units Probable

Unfortunately for new developments the present need for additional capacity must meet present economic requirements of very low cost stations which offer little chance for development of new types of equipment. Turbine manufacturers have been complaining for years that prices could not be reduced while each new station demanded an entirely new and distinctive type of unit. Under present conditions this standardization of size and type will take place, the trend of recent years seeming to be toward the tandem compound turbine.



THE TURBINE ROOM AT "K" STREET STATION, AT LINCOLN, NEBRASKA

Developments in the mercury vapor field, as carried on for several years at Hartford, have materialized and two binary vapor plants are under construction at the present time. One industrial plant at Schenectady and one central station at Kearny. Both plants will use 20,000-kw. mercury turbines, an increase in size of 100 per cent over the South Meadow unit. The mercury pressure has also been increased from 71 to 125 lb. gage and the exhaust pressure from 1.5 to 3.0 in. abs. in order to increase the steam pressure from 275 to 400 lb. pressure. Mercury walls will be installed in the top half of the furnace and water walls in the bottom. Both plants will burn pulverized coal. At Schenectady the

steam produced will be used in process and heating but at Kearny it will be used in a 33,000-kw. turbine.

Higher Pressure Engines

Unquestionably the most interesting prime movers in the stations covered by this year's list are the two 6000-hp. reciprocating engines at the Philip Carey plant. These are vertical, five cylinder, triple expansion units with steam reheat to 525 deg. F. between the intermediate and low pressure cylinder. Throttle conditions are 1440 lb. 800 deg. F. and the engine exhausts at 60 lb. to an industrial evaporator.

Each engine has two 14 3/16 in. dia. high pressure single acting cylinders and two 21¼ in. dia. intermediate single acting cylinders. The 33½ in. low pressure cylinder is double acting and the stroke is 25⅝ in. Each engine is direct connected to a 4700 kv.a., 2300 v. generator. A reciprocating boiler feed pump driven by a 750 hp. vertical engine is used.

These machines are unique not only because of their size but because of the high pressure, the highest in use in this country today. They are not the only engines on the list, however, as half of the industrial plants in this year's list use engines. This is interesting, not because it shows a trend back to engines, but rather because it indicates increased interest in small power plants where the engine is eminently suitable. Just where the dividing line between the turbine and engine can be drawn is impossible to say, although the greater economy of the engine leaves it practically unchallenged in plants having a total capacity of 500 to 1000 kw.

Industrial automatic extraction turbines of one and two extraction stages have been highly developed and extensively used. Control equipment is, however, expensive and during recent months there appears to be a definite demand for simple equipment layouts which give somewhat the same result as far as the heat balance is concerned.

Whether these opinions are fundamentally sound and will endure is questionable. The simpler equipment, engines or turbines operating against back pressure offer low construction costs, fit in well with present low pressure equipment and offer little disturbance to well established heat balances. An excellent example of this is given by the recent addition of high pressure plants by the Pennsylvania Sugar Co. and by Hollingsworth & Whitney.

It seems, however, that closer cooperation of large industrial plants and public utilities is inevitable. Except for dump power interchange, (practically of no value to the utility at the present time) some degree of availability must be demanded if such interchange is to be of mutual advantage. For this purpose condensing extraction turbines of the type represented by the Purdue University plant would be the most practical and flexible piece of equipment. Suitable condensing equipment (Champion Coated Paper Co. 1931) under an extraction turbine is a simple and cheap method of evening out the fluctuations between power and steam demands where these fluctuations are beyond the time and capacity range of an accumulator.

PRIME MOVERS

STATION	NO. & RATED CAPACITY MAIN TURBINE KW.	GENERATOR RATING KW.	DIRECT CONNECTED EXCITER KW.	SHAFT GENERATOR KW.	TYPE TURBINE	SPEED R.P.M.	STEAM CONDITIONS: THROTTLE LB. ABS.	THROTTLE DEG. FAHR.	REHEAT AT LB. ABS.	REHEAT AT DEG. FAHR.	EXHAUST LB. ABSOLUTE OR INCHES VACUUM	STEAM FLOW TO THROTTLE AT RATED LOAD	EXTRACTION AT RATED LOAD: TOTAL LB. PER HR.	PER CENT TOTAL TO THROTTLE	EXTRACTION POINTS: FIRST LB. ABS.	FIRST DEG. FAHR.	SECOND LB. ABS.	SECOND DEG. FAHR.	THIRD LB. ABS.	THIRD DEG. FAHR.	FOURTH LB. ABS.	FOURTH DEG.	FIFTH LB. ABS.	FIFTH DEG. FAHR.	PURPOSE
QUINDARO	1–10,000	10,000	80	—	HORIZONTAL SINGLE CYLINDER	3,600	415	700	—	—	29"	108,000	18,000	16.7	10	193	29	295	68	347	—	—	—	—	FEED HEATING AND EVAPORATING
K STREET	2–7,500	8000 KW. AT 70% P.F.	80	—	HOR.- 1 CYL. AUTO. EXTR.	3,600	565	725	—	—	27"- 29"	80,000 TO 135,000	10,000 TO 100,000	14.0 TO 75.0	12.3	203	35	278	PROCESS 103	PROCESS 445	PROCESS 141	PROCESS 505	—	—	PROCESS, HTG. STM.& FEED HTG.
HARDING STREET	2-36,750	35,000	SEPARATE	1,750	HOR. SINGLE CYLINDER	1,800	400	700	—	—	28 1/2"	378,000	68,658	18.1	5.2	163.9	DEAERATOR 18.7	224.4	70.1	387.9	—	—	—	—	FEED HEATING & EVAPORATING
CODY	1–3,000	3,000	22.5	—	HOR. SINGLE CYLINDER	3,600	365	740	—	—	28"	33,800	6,300	18.6	14.1	275	DEAERATOR 48.6	420	113	587	—	—	—	—	FEED HEATING & EVAPORATING
PASADENA	1–25,000 ▲	25,000	125	—	HOR. SINGLE CYLINDER	1,500	415	750	—	—	28"	268,000	70,180	26.9	6.42	173	23	236	98.5	326.8	256	405.1	—	—	FEED HEATING & EVAPORATING
KIDDER	1–7,500	7,500	45	—	SINGLE CYL.	3,600	315	600	—	—	28 1/2"	43,800	22,800	24.1	7.8	182	23.3	236	53.7	300	152.7	486	—	—	FEED HEATING
DODGE CITY	1–6,000	6,000	37	—	HOR. SINGLE CYLINDER	3,600	375	740	—	—	29"	72,000	13,600	18.85	10.9	196	DEAERATOR 47	302	117	548	—	—	—	—	FEED HEATING & EVAPORATING
HOLLINGSWORTH & WHITNEY	1–3,000	3,000	22	—	HOR. NON-COND.	3,600	435	575	—	—	135 LB.	—	—	—	—	—	—	—	—	—	—	—	—	—	AUXILIARY & INDUSTRIAL USE
PHILIP CAREY	ENGINES 2–3,750	3,750	52	—	5 CYL. TRIPLE EXPANSION	225	1440	800	STEAM 250	REHEAT 525	60 LB.	70,000	—	—	—	—	—	—	—	—	—	—	—	—	HEATING
PURDUE UNIVERSITY	1–2,500	2,500	—	—	HOR. SINGLE CYLINDER	3,600	205	560	—	—	27" COND. 25 LB. NON-COND	34,000 COND. 74,000 NON-COND	60,000	58	25	?	—	—	—	—	—	—	—	—	HEATING
WEST FARGO								NO		GENERATING	EQUIPMENT														
RADFORD	ENGINES 1–600	600	—	—	28 X 36 IN. UNIFLOW	150	190	—	—	—	15 LB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PENNSYLVANIA SUGAR CO.	1–2,000	2,000	—	—	EXTRACTION	—	415	500	--	—	25 LB.	—	—	—	105	331	—	—	—	—	—	—	—	—	PROCESS
CLARIDGE	ENGINES 3–200	200	BELTED	—	4 CYLINDER VERTICAL	400	190	SAT.	—	—	18 LB.	—	—	—	—	—	—	—	—	—	—	—	—	—	HEATING
PILGRIM HOSPITAL	ENGINES 1-700 2-1350	700 1,350	15 25 BELTED	—	4 VALVE 20"X36" SINGLE 20"X36" DOUBLE	133	185	SAT.	—	—	15 LB.	—	—	—	—	—	—	—	—	—	—	—	—	—	HEATING
LONGVIEW HOSPITAL	ENGINES 2–200 ▼ 1–130	200 130	BELTED	—	UNIFLOW 18 (2X) IN. 16 (2X) 20 IN.	200 225	215	SAT.	—	—	20 LB.	6,540 4,845	—	—	—	—	—	—	—	—	—	—	—	—	EXHAUST FOR FEED & WATER HEATING
CHASE BRASS & COPPER CO.								NO		GENERATING	EQUIPMENT														
BRUNSWICK LAUNDRY	ENGINES 1–150 1–250 1–700	1–150 1–250 1–700	? ? ?	— — —	ALL CORLISS 18X36" 24X36" 30X48"	100 100 100	180	SAT.	—	—	20 LB.	—	—	—	—	—	—	—	—	—	—	—	—	—	EXHAUST FOR FEED HEATING
SPRINGWELLS	2–5,000	5,000	35	—	HOR. SINGLE CYLINDER	3,600	380	700	—	—	28 1/2"	59,270	12,270	20.7	11	198	43	337	—	—	—	—	—	—	FEED HEATING & EVAPORATING
NOTRE DAME UNIVERSITY								NO		GENERATING	EQUIPMENT														

—NO EQUIPMENT INSTALLED OR NOT APPLICABLE ? REQUIRED DATA NOT FURNISHED ▲ PLANT EXTENSION

CONDENSERS *and* AUXILIARIES *show* LITTLE CHANGE

Welded Condenser Shells and Continued use of External Coolers only Development of note. Extraction Heater Practice shows 5 to 10 deg. F. temperature difference between Steam and Water sides.

HAVING REACHED, last year, the almost unbelievable proportions of 101,000 sq. ft. of cooling surface in a single condenser shell, there is little possibility of this record being surpassed for some time to come. The record breaking condensers, for there are two, are installed in Hudson Ave. Station and were described in detail on page 750 of the November 1932 issue. Hudson Ave. Station was included in last year's list of stations although it was not put in operation until shortly after the first of 1932.

An interesting feature of the units was the specifications which beyond the space and water limitations placed no restrictions on surface, number of passes or tube length, simply stating that the condenser should maintain an absolute pressure of not more than 2¼ in. of mercury with a heat projection to the circulating water of 1180 million B.t.u. per hour with 73 deg. F. circulating water.

Heat transfer coefficients were to be based on 70 per cent of the heat transfer of commercially new clean tubes. Facilities are provided for determining the heat

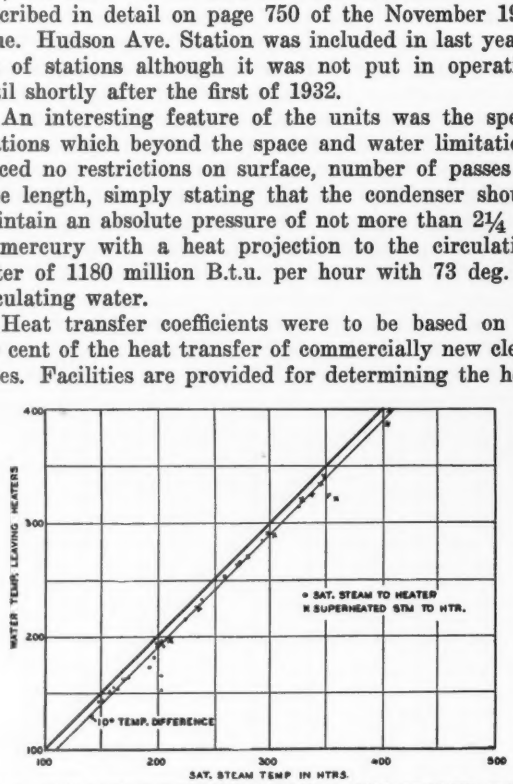


FIG. 1. RELATION BETWEEN STEAM AND WATER TEMPERATURES OF EXTRACTION HEATERS AT FULL LOAD

transfer under normal operating conditions by installing six groups of five tubes each, which can be isolated by hose jumpers connected through special covers in the waterbox manholes. One group of these tubes as installed in the condenser are shown by photogragh Fig. 2. In addition, the specifications give the effect of vacuum on the heat consumption of the turbine, steam values and the basis by which the condenser performance would be evaluated.

In the smaller sizes especially, interest in welded condenser shells continues to increase, one of the recent interesting jobs being the unit for the new addition to the Colorado Springs, Colo., municipal plant. These units offer advantages in lower first cost, lower freight charges, elimination of air leakage through cracks, ease with which expansion of tubes rolled at both ends can be taken care of and, consequently, the virtual elimination of condenser leakage. The largest shell yet constructed by welding is the 65,000 sq. ft. condenser for the 75,000 kw. unit at Kearny Station.

Air Coolers

There is also a consistent steady progress in the use of external air coolers in condensers. As ordinarily constructed, a section of the condenser cooling surface, sometimes as high as 25 per cent, is baffled off from the steam condensing surface. The purpose of this section

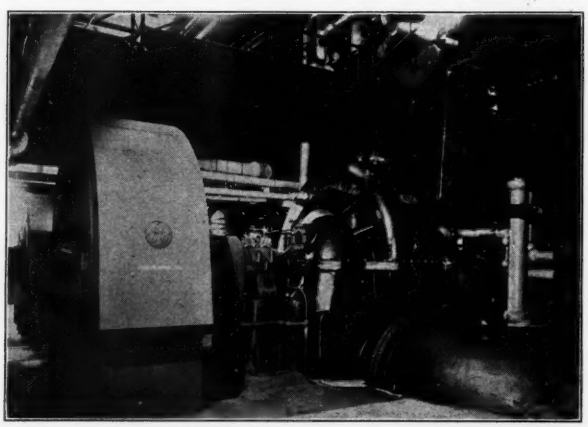


FIG. 2. ONE CIRCULATING PUMP AND A CORNER OF THE WORLD'S LARGEST CONDENSER (HUDSON AVENUE STATION). A SPECIAL MANHOLE FOR TESTING PURPOSES IS VISIBLE IN THE UPPER RIGHT HAND CORNER

is to cool the air before it reaches the vacuum pump section, so as to condense out the steam and also to reduce the volume of air handled by the vacuum pump.

Running the full length of the shell, as this section does, its efficiency as a cooling apparatus has been questioned. By cooling the vapors in a small section external to the main shell, better baffling and multipass arrangements can be used and the desired cooling effected by a much smaller surface, usually 500 to 1000 sq. ft. Of recent years each review issue has seen a number of units so equipped and it is probable that before long the absence of more important controversial questions will bring the air cooler section to the fore as the single pass vs. double pass question was so placed a few years ago.

This latter question has been settled by the logical decision that both types had definite advantages for certain conditions. As it happens all the units in this year's list are two pass but this must not be misconstrued as a trend away from single pass construction. In fact, of recent years the trend has been very decidedly toward single pass until the field of the single pass unit was recognized. Today single pass and double pass units

stand on about the same basis as pulverized coal and stokers. Each has a definite field, influenced by local conditions, but these two fields sometimes overlap somewhat so that controversies are not entirely eliminated.

Continuing the trend toward electric auxiliaries the year's list of central stations is practically 100 per cent motor drive, although some of the industrial plants are using steam auxiliaries for heat balance purposes. One plant, Hollingsworth & Whitney, had a rather unusual condition to meet because no returns are received from the mill and steam auxiliaries were advisable to supply steam for feedwater heating. As with the Pennsylvania Sugar plant the new equipment is tied in with the old. Both of these stations warrant close study by industrial engineers because of the way the power facilities were increased to take full advantage of installed equipment and care for future growth.

Another plant designed and installed with an eye to future conditions was the Radford plant where non-condensing engines are installed. The engines, piping and buildings are so arranged, however, that condensing equipment can be added as soon as the load increases to the point where the savings in operating cost will justify the expense of condensing equipment. Situations like this complicate the industrial power problem. Where a central station engineer deals largely with a selection of equipment to meet certain load electric conditions, the industrial engineer's problem is involved with the selection of arrangements and methods of supplying both steam and electric power as well as selecting the equipment.

Two circulating pumps per unit is now almost universal practice. The same is true of condensate pumps although Harding St. offers an interesting departure from this practice. There three pumps are installed, two being required for full load operation. This arrangement decreases the power consumption at partial loads and requires a total pump capacity of 600,000 lb. per hr. instead of the usual 800,000 lb. per hr.

Twin two stage steam jet vacuum pumps are used almost exclusively and usually the inter and after coolers form the first heater encountered by the condensate in its flow from the hotwell to the boiler. Isolated cases of separate cooling water supply for these coolers is encountered but apparently this tendency, which seemed to indicate a trend a few years ago, has died out.

Generator air and oil coolers are seldom included in the list of condensate heaters, however, and the use of a separate evaporator condenser seems to be disappearing, the tendency being to use the next lower extraction heater for condensing the evaporator vapor. Data from this and last year's stations indicates that in the majority of cases closed heaters bring the condensate within 10 deg. F. of saturated steam temperature in the heater at full load operation. Many stations heat within 5 deg. F. as shown by Fig. 1. Apparently superheater steam to the heater makes no difference, although heaters have been developed to take advantage of the superheated steam heat head. Seemingly the gain does not warrant the added construction cost.

CONDENSERS AND AUXILIARIES

STATION	TURBINE RATING KW.	TOTAL SURFACE IN SHELL		AIR COOLER SECTION		STEAM TO CONDENSER AT RATED LOAD LB. PER HR.	PASSES	TUBES	PACKING	EXPANSION JOINT OR SOLID CONNECTION TO TURBINE	CIRCULATING PUMPS					CONDENSATE PUMPS			VACUUM PUMPS		
		SQ. FT.	SQ. FT. PER KW.	INTERNAL OR EXTERNAL	SURFACE SQ. FT.						NO.	CAP. EACH G.P.M.	DRIVE	MAX. G.P.M. PER K.W.	RATIO LB. WATER PER LB. STEAM	NO.	CAP. LB. PER HOUR	DRIVE	NO.	TYPE	TOTAL CAPACITY C.F.M.
QUINDARO	10,000	15,000	1.5	EXTERNAL	117	90,000	2	1"O.D. X 20'-0"	1 ROLLED 1 PACKED	EXP. JOINT	3 ▼	2-21,000 1-14,000	2300 V. IND.	—	—	2	135,000	2300 V. INDUCTION	1	TRIPLE ELEMENT 2 STAGE	60 LB/HR.
K STREET	7,500	7,425	0.99	INTERNAL	?	VARIABLE	2	3/4" X 18'-0" NO. 18 B.W.G.	ROLLED BOTH ENDS	SOLID	3	7,700	1 TURBINE 2 VAR. SP. MOT.	1.05	—	4	75,000	MOTOR	2	STM. JET	16.25 EACH
HARDING STREET	36,750	33,000	0.898	INTERNAL	?	310,350	2	7/8" O.D. X 22'-0" NO. 18 B.W.G.	INLET-SPECIAL FERRULE & LEAD RING-OUTLET PACKED	SOLID	2	17,500	1150 R.P.M. — 2300 V. IND. MOTOR	0.952	56.4	3	200,000	A.C. MOTOR	1	DUPLEX 2 STAGE STM. JET	40 C.F.M. AT 29 IN. & 70° F.
CODY	3,000	2,950	0.985	EXTERNAL	50	27,500	2	3/4" O.D. X 14'-0" NO. 18 B.W.G.	ROLLED BOTH ENDS	SOLID	2	1500	50 HP-1200 R.P. IND. MOTOR	1.0	50	2	37,500	A.C. MOTOR	1	DBL-2 STG. STM. JET	32 LB./HR. AT 29", 65 DEG.
PASADENA	25,000	25,600	1.016	EXTERNAL	600	198,820	2	7/8" O.D. X 22'-0" 18 B.W.G.	1 ROLLED 1 PACKED	SOLID	2	1-10,000 1-20,000	200 HR 750 RPM 2300 V. SYNCR. 350 HR 600 RPM	1.20	73.5	2	600,000	1 MOTOR 1 TURBINE	1	2 STAGE STEAM	34 C.F.M. AT 28"-102° F.
KIDDER	7,500	8,000	1.07	INTERNAL	?	71,200	2	3/4" O.D. NO. 18 B.W.G.	ROLLED BOTH ENDS	SOLID	2	4,000	1 TURBINE 1 DUAL	0.668	27.0	1	120,000	DUAL	1	STEAM JET	14.7 C.F.M. AT 28.5"-70°F.
DODGE	6,000	7,500	1.25	INTERNAL	?	59,400	2	3/4" X 16'-4" O.D. B.W.G. ARSENICAL COPPER	ROLLED BOTH ENDS	SOLID	—	—	FROM DEEPWELL PUMPS	—	—	2	50,000	1750 RPM SQ. CAGE	1	DOUBLE 2 STG.	8.5 C.F.M. AT 1.0"
HOLLINGSWORTH & WHITNEY	NON-CONDENSING																				
PHILIP CAREY	NON-CONDENSING																				
PURDUE UNIV.	2,500	2,530	1.001	INTERNAL	?	34,000	2	3/8" O.D. X 10'-0" NO. 18 B.W.G.	ROLLED	SOLID	1	4,350	1160 R.P.M. 2300 V. IND. MOTOR	1.74	63.8	1	57,500	1155 RPM 440 V IND. MOT.	1	DUPLEX 2 STG. STM. JET	20
WEST FARGO	NON-CONDENSING																				
RADFORD	NON-CONDENSING ENGINES WITH PROVISIONS FOR CONDENSING LATER																				
PENNSYLVANIA SUGAR CO.	NON-CONDENSING																				
CLARIDGE	NON-CONDENSING																				
PILGRIM HOSPITAL	NON-CONDENSING																				
LONGVIEW HOSPITAL	NON-CONDENSING																				
CHASE BRASS & COPPER CO.	NON-CONDENSING																				
BRUNSWICK LAUNDRY	NON-CONDENSING																				
SPRINGFIELD PUMPING PLANT	5,000	10,000	2	INTERNAL	?	47,000	2	3/4" O.D. X 17'-8" NO. 18 B.W.G.	1 ROLLED	SOLID	2	4,025	250 V. D.C. MOTOR	1.57	6.81	2	124,800	250 V. D.C. MOTOR	1	DOUBLE 2 STAGE	55 LB/HR.
NOTRE DAME UNIV.	NON-CONDENSING																				

— NO EQUIPMENT INSTALLED OR NOT APPLICABLE ? REQUIRED DATA NOT FURNISHED ▼ IN CITY WATER WORKS

POWER PLANT ENGINEERING January 1933

DIVERSIFICATION *Is Keynote of* HEAT BALANCE PRACTICE

Where Central Station Heat Balances are becoming standardized, Industrial Heat Balances are becoming more varied to meet increasingly complicated demands.

PERHAPS the most noticeable feature of this year's list of central stations is the standardized flow diagram. Quintaro, Harding Street, Cody, Dodge and Springwells might well be fitted to a single standard diagram with but a few minor detailed changes of drains and vents. Pasadena with four closed heaters and no deaerating heater stands alone although there is little reason to believe that the popularity of this completely closed cycle is waning. Next year the new Port Washington Station will be completed and will use a somewhat similar system but with the boiler feed pumps on the low side of all the extraction heaters.

Boiler Feed Pumps

In this way the feed pump will pump comparatively cool water and because of the difference in density of hot and cold water, will require approximately 15 per cent less power than if placed immediately preceding the boilers. This scheme has been used before (James H. Reed, 1930) and as feed pump power consumption and maintenance cost increases with pressure and temperature, the importance of the closed cycle with the feed pump handling comparatively cool water is bound to increase. The disadvantage lies in the cost and expected difficulties with high pressure heaters, a disadvantage that is probably more imaginary than real, considering the experience with high pressure oil heaters.

As pressures increase, the auxiliary power, especially for the feed pumps, increases, even though the heat rate and consequently the steam flow per unit of output decreases somewhat. An interesting feature of this problem was brought out in connection with the new units being installed at State Line. The throttle pressure is being increased from 600 to 1200-lb. and because of higher efficiency and what is believed to be greater reliability reciprocating feed pumps will be used for the higher pressures. In this addition the boiler feed pressure will be increased 60 per cent, but the water pumped will be decreased 17.5 per cent and the feed pump efficiency increased 30 per cent, giving a net increase in power consumption of about $160 \times 0.835 \div 130$ or somewhat less than three per cent. Gas reheat to 825 deg. F. and a full extraction cycle will be used.

Heat Extraction

Arguments regarding the advantages of extraction are now a matter of history but it is questionable if full advantage is always taken of this feature when new units are placed in old stations. This year the best example of modernization is given by Kidder Station where condensate from an older non-extraction unit is heated by steam bled from the new unit installed this summer. This adds 110 deg. F. increase in temperature to the condensate from the old machine. In a two unit station this feature cannot be utilized to full advantage because but one unit is running much of the time. In a station with several units (Cahokia, 1930) the scheme can be used to greater advantage.

Although the extraction cycle has done much to increase thermal efficiency much remains to be done. Reduction of the condenser loss is a fertile field and in this year's list the most outstanding central station is unquestionably the K Street Station at Lincoln, Neb. Expanding 565 lb., 725 deg. F. steam to 28 in. in a

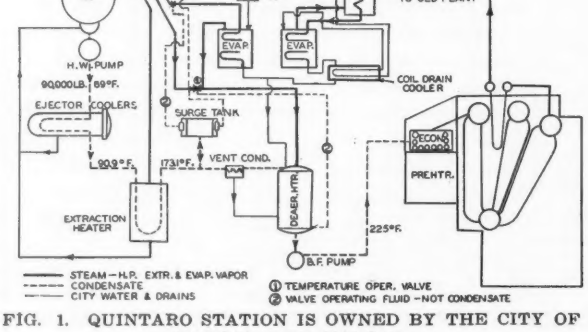


FIG. 1. QUINTARO STATION IS OWNED BY THE CITY OF KANSAS CITY, KANSAS

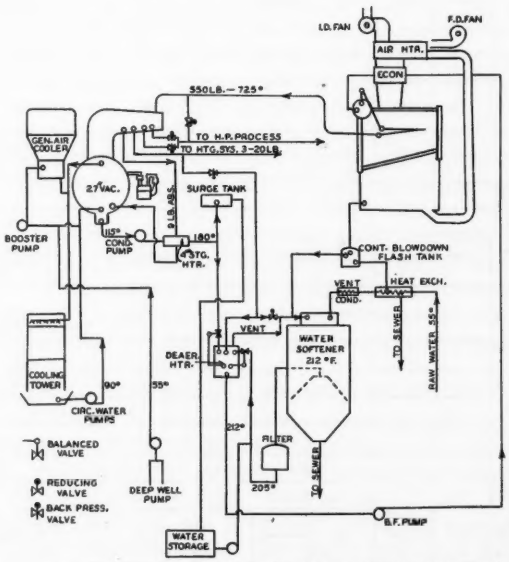


FIG. 2. K STREET STATION SELLS EXTRACTED STEAM AT TWO PRESSURES

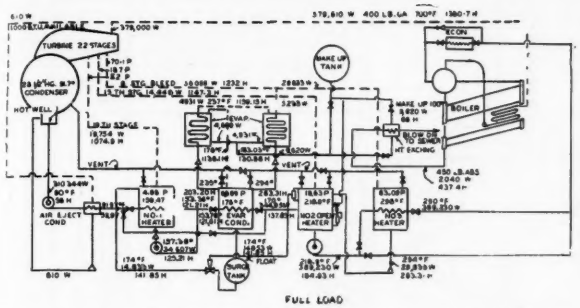


FIG. 3. HARDING STREET STATION HEAT BALANCE AT 36,750-KW.

single machine, extracted steam is sold at two pressures, 125 lb. for process and 20 lb. for heating. Full load steam flow to the 7500-kw. machines varies from 60,000 to 125,000 lb. per hr., depending upon the amount extracted. This varies from 10,000 to 100,000 lb. per hr. or up to a maximum of about 75 per cent of the flow to the turbine. Reducing the condenser loss by this amount is a much cheaper method of increasing the station thermal efficiency than is either high pressure or high temperature.

Both high temperature and mercury vapor plants are, however, receiving a great deal of attention. The 1000 deg. unit at Delray has been operating at that temperature over a year with very minor difficulties. Mercury vapor plants at Schenectady and Kearny are under construction and should be in operation next fall. Both of these should materially influence future construction but without greatly changing the present cycle.

Evaporators

Much activity has been noticeable in the industrial field and the Philip Carey 1800 lb. plant has been in operation practically a year. The flow diagram as shown gives the essential features of the plant. Engines used as prime movers are described in more detail in the prime mover article. Steam reheat to 525 deg. F. is used and the boiler and turbine form a closed feedwater system. Engines exhaust at 60 lb. to an industrial evaporator or heat transformer which supplies 45 lb. process steam to the mill while heating steam from the reheater flows to another evaporator which supplies 100 lb. process steam.

Another plant having an interesting evaporator in-

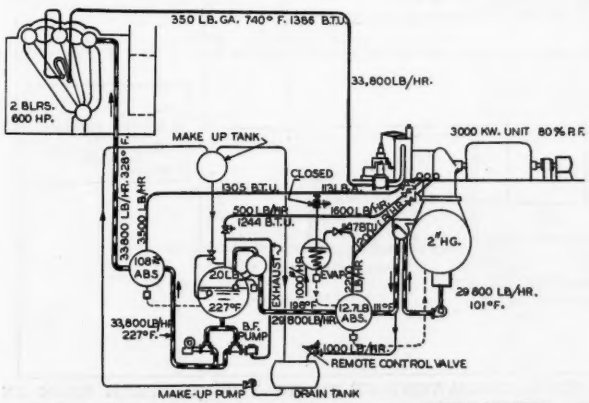


FIG. 4. CODY STATION HEAT BALANCE AT 2950-KW.

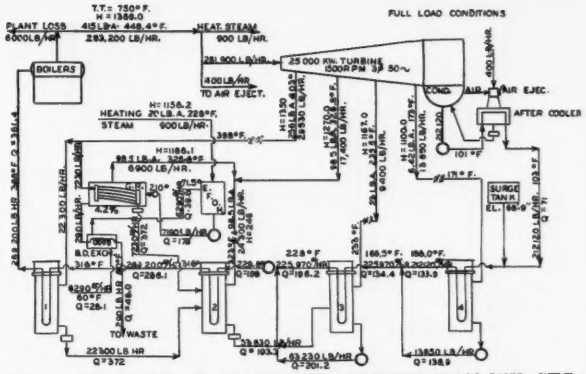


FIG. 5. HEAT BALANCE FOR THE LATEST 25,000-KW. SECTION OF PASADENA (CAL.) STEAM PLANT AT FULL LOAD

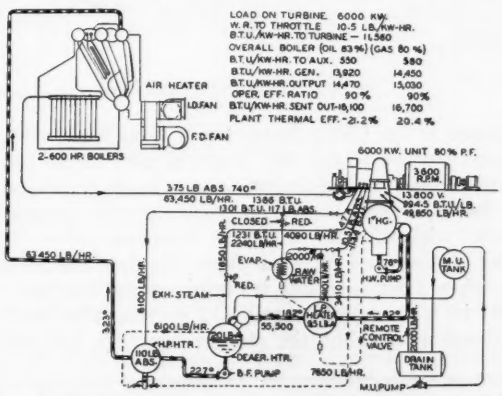


FIG. 6. DODGE CITY STATION CONDITIONS AT A LOAD OF 6000-KW.

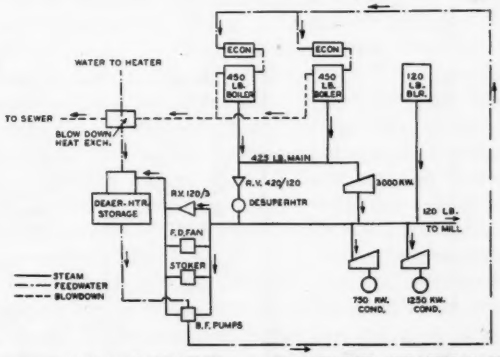


FIG. 7. HOLLINGSWORTH & WHITNEY STATION USES HIGH PRESSURES AND NON-CONDENSING TURBINES

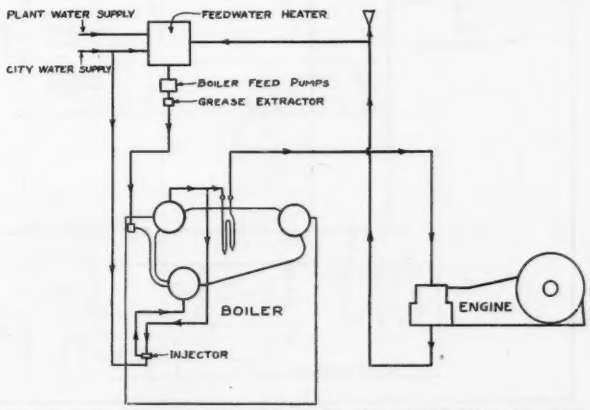


FIG. 8. RADFORD STATION IN WHICH PROVISION HAS BEEN MADE FOR CONDENSERS WHEN LOAD INCREASES

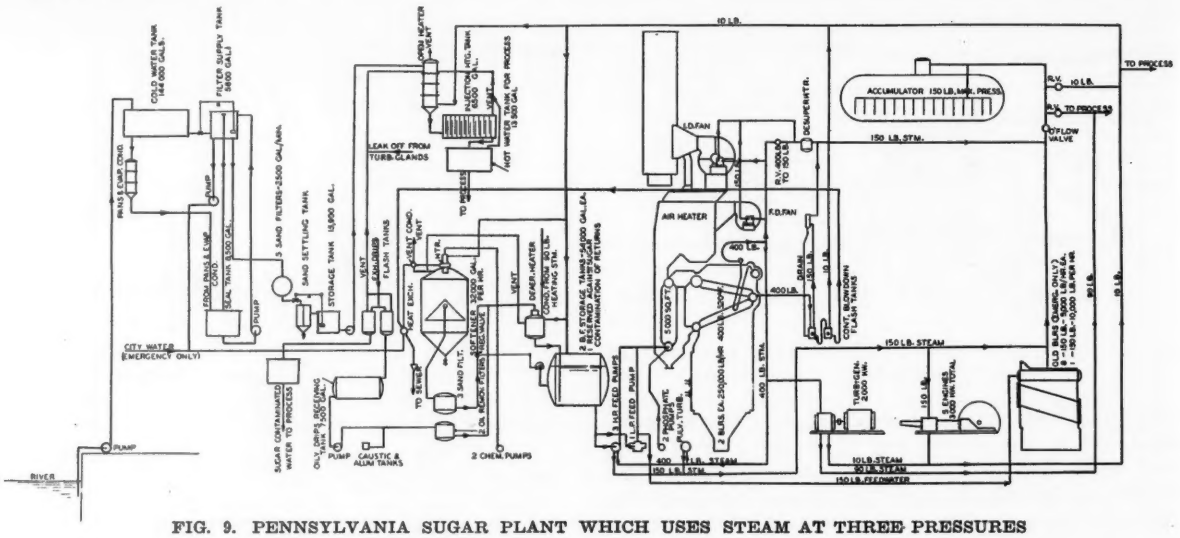


FIG. 9. PENNSYLVANIA SUGAR PLANT WHICH USES STEAM AT THREE PRESSURES

stallation is the Chase Brass plant using 200 lb. steam. A large portion of the 100 lb. steam used in the process is not returned as condensate and to make up the quantity lost a 20,000 lb. per hr. evaporator is operated in parallel with the 200 to 100 lb. reducing valve. Evaporator drains and returns from the heating systems, also taken from the 100 lb. mill supply line, are collected in a storage hot well. At present this company purchases power but the station has been laid out so that generating equipment can be added in the space now occupied by two motor generator sets.

Whether to generate or purchase power is becoming a more difficult decision for industrial plants. Cheaper rates on one hand and better facilities for heat balance purposes on the other bring the two close together. There is, however, an increasing demand for power interchange agreements with utilities and apparently a somewhat more liberal attitude on the part of utilities

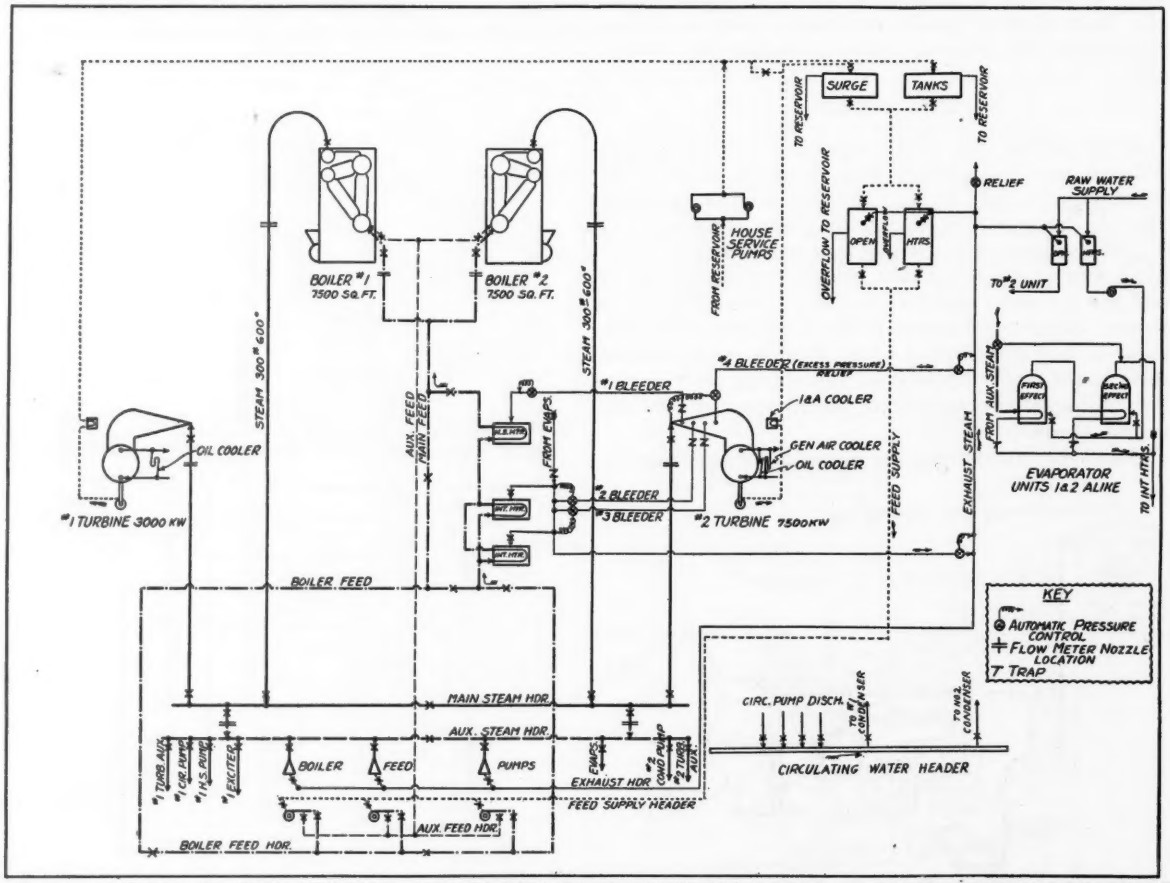


FIG. 10. KIDDER STATION SHOWING APPLICATION OF EXTRACTION TURBINE TO HEAT CONDENSATE FROM AN OLDER NON-EXTRACTION UNIT

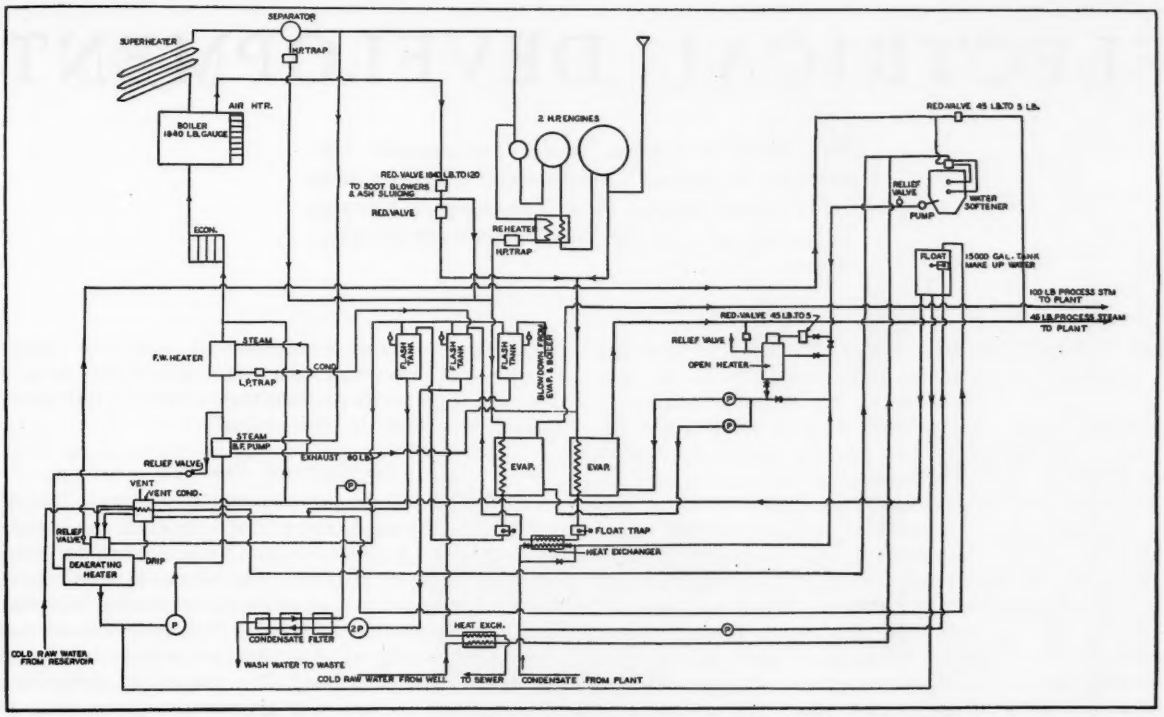


FIG. 11. THE 1800-LB. PHILIP CAREY PLANT IS THE MOST TALKED OF INDUSTRIAL PLANT IN AMERICA

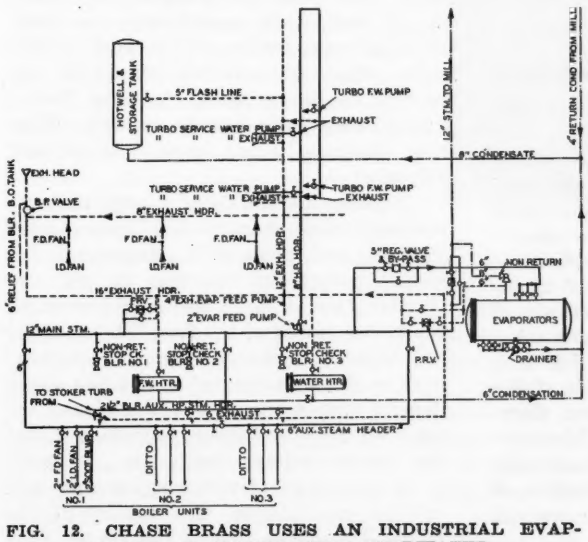


FIG. 12. CHASE BRASS USES AN INDUSTRIAL EVAPORATOR TO INSURE PURE FEEDWATER

toward such agreements. This will undoubtedly have a far reaching influence on industrial plant design and layout within the next two or three years.

Back pressure turbines can, of course, be widely applied in industrial plants, an excellent example of such practice being in the new Pennsylvania Sugar plant where steam at 400, 150, 90 and 10 lb. is used in the power plant or industrial plant. The new plant was tied in with the old without disturbing the heat balance. Fan, pulverizer and boiler feed pump turbines for the new high pressure boilers use 400 lb. steam and exhaust at 150 lb. This exhaust combines with the output of the old boilers and is then used by the old engine generator sets which exhaust at 10 lb. A new turbo-generator takes steam at 400 lb., bleeds at 90 lb. for process and exhausts to the 10 lb. system. Boiler feed requirements in excess of returns and drips are made up from the Delaware River and treated in a hot process softener.

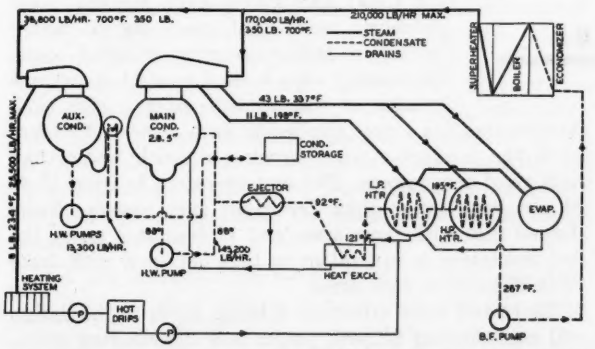


FIG. 13. SPRINGWELLS STATION WAS BUILT TO SUPPLY POWER FOR PUMPING A PORTION OF DETROIT'S WATER

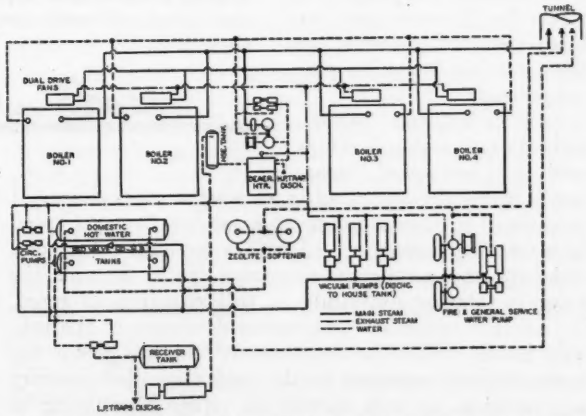


FIG. 14. NOTRE DAME STATION SUPPLIES HEAT AND HOT WATER TO A LARGE UNIVERSITY

POWER PLANT ENGINEERING January 1933

ELECTRICAL DEVELOPMENTS IN

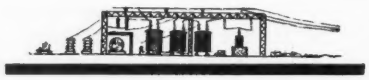
New types of motors. Better Transmission Line Practice. Improved Transformers. Higher ratings for Circuit Breakers. New Researches in Vacuum Tubes are some of the Year's Important Developments.

IN DIRECTING attention to the most outstanding electrical developments this year, it would be most logical to begin with those concerning the generation of electrical energy, but since generators as such are discussed in greater detail in a separate article on page 36, we will omit reference to them here and begin our discussion with a consideration of motors.

Although electric generators and motors come under the same general classification, that is, electro-dynamic machinery, motor development proceeds along different lines, first because of the difference in size and capacity and secondly because of the applications for which they are intended. There has been considerable activity during the past year in the development of improved type induction motors, particularly those for use in steel mills. These motors are of the low inertia type with liberal radiating surface, adapting them for heavy reversing duty. The use of totally enclosed fan motors has increased enormously, one manufacturing company reporting that over half of its induction motor output for last year was of the fan-cooled type. Two interesting motors are being installed at State Line Station for driving 1500 lb. per sq. in. boiler feed pumps. These are two 2500 hp., 282/708 r.p.m. constant torque induction motors using the Rossman system of speed control. This is the first instance where the d.c. armature has been mounted directly on the rotatable induction motor primary.

An interesting experimental small motor development is a low speed "gearless" motor demonstrated in an electric clock drive. It consists of a rotor running at a sub-synchronous speed in a rotating magnetic field with a constant reluctance, although the minimum reluctance path through the rotor is rotating uniformly at full synchronous speed.

Another rather startling motor development is a railway motor without a commutator.[2] In this motor the commutator is replaced by the grid controlled mercury arc rectifier. It will operate on either alternating or direct current. The rectifier eliminates more than the commutator—it also eliminates all expensive control switching and reversing equipment; indeed this development shows so much promise that a 1000 hp. locomotive is now being built in Switzerland.



DESPITE the lack of new construction in the field of power generation and distribution during the year, development in the electrical field as a whole has proceeded at a satisfactory rate. New discoveries, new principles of application, improvements in methods of manufacture, more efficient methods of operation have followed each other in such rapid succession that it is scarcely possible in an article of this length even to enumerate them. ¶ The electrical research laboratories all over the world are continually making possible new applications of that great universal force we call electricity.

Transmission Practice

In the long distance transmission of power, development has continued along lines striving for greater reliability and higher economy both as regards investment and operating costs. One phase of transmission line work which has received little treatment heretofore is that of conductor vibration. This year several comprehensive studies of this phenomena have been made and the results published.[3] The results are rather complex but they indicate that the theoretical formulas for calculating vibration are in good agreement with field observations. It is also shown that while modification in shape of cable cross-section and stranding have some effect in reducing amplitude the results do not support the idea that a vibrationless cable can be evolved. Effective dampers it is shown will prevent vibration.

Another investigation[4] showed that two overhead conductors a few inches apart used for each phase of a transmission line circuit reduce the reactance 20 per cent or more, thus in many instances increasing the power rating of the line. The costs for this type of construction are higher, however, so the feasibility of such a line would depend upon economic considerations. Another advantage of this construction is that the corona voltage limits are increased.

A new type of construction was used in the transmission line towers of the Osage-Rivermines line of the Union Electric Light and Power Co.[5] Hinged wood crossarms were used, resulting in better insulation and consequent reduced costs. These arms were hinged to steel structures because of cost considerations; with such construction the forces applied to both arms and towers when the conductor wires break are much lower than with rigid arm towers. The cost therefore is from 15 to 20 per cent lower than for rigid arm towers. Tests showed that with these arms and 11 insulator units, the line insulation is equivalent to that obtained with from 17 to 23 units on steel arms.

More and more attention is being given to the design and construction of both power and distribution transformers which will better withstand lightning surges. A

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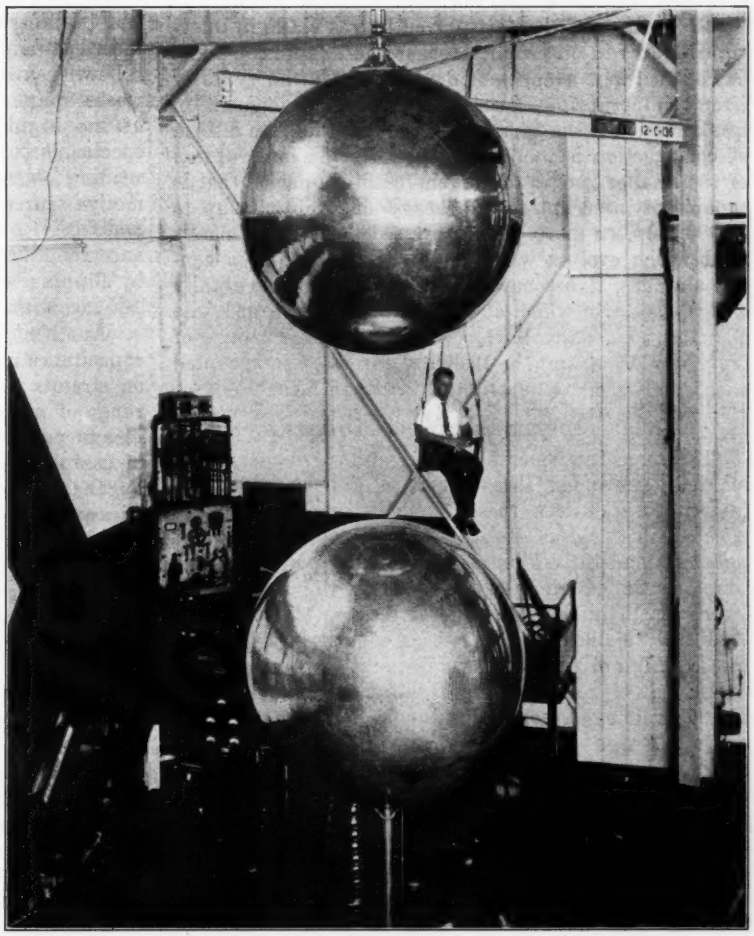


number of large shell-type surge-proof power transformers were built, among them a unit of 42,000 kv-a. 220 kv. which were subjected to unusually severe impulse tests. Another, a 70,000 kv-a. unit for the United Electric Light and Power Co., is thought to be the largest of the self-cooled type in this country. Two transformers of new design were furnished to operate an X-ray tube for cancer research in the California Institute of Technology, each rated at 0.03 ampere at 700,000 v. to ground. These units operate in series, with the mid point grounded, giving 1,400,000 v. effective at the X-ray tube.

There has been considerable development in the design and construction of surge-proof transformers in several different classes of service. In distribution transformers, features of protection against lightning independently of transformer connections or grounding practice were accomplished by incorporating high voltage deion gaps and coordinated low voltage bushings within the units. A new type of Inertaire protection of power transformers[6] using nitrogen from a gas cylinder was perfected. In another instance, a uni-directional breather for use on power transformers was developed. This device induces a natural circulation of air over the oil in the main transformer tank or expansion tank to reduce condensation and to carry off moisture.

Of particular interest to power plant operators is a new transformer-rectifier equipment for supplying high potential direct current to electrostatic precipitator installations. In this equipment four two-element high vacuum tubes having sturdy construction are mounted on top of the transformer, providing single phase full wave rectification. Glass cylinders surrounding the tubes protect against hazard due to X-ray emanations which tests show accompany any high voltage electronic rectification. The equipment is capable of delivering an output of 400 ma. at a maximum r.m.s. potential on the transformer of 100,000 v. The filament transformers required are mounted in the same tank as the main transformer.

Magnetic oil level indicators are now available for power, large distribution and high voltage instrument transformers. This gage has numerous advantages over a glass oil gage because it is more easily read and more easily maintained oil tight.

Circuit Breakers and Fuses

Although no radically new developments in circuit breaker practice occurred during the year, both the deion and the oil blast type of breaker have been subjected to improved design and greater refinement. Both types of breakers were extended to quite high ratings and both types have appeared in the metal-clad construction. Three million kv-a., 220 kv. oil circuit breakers of the deion grid type were installed and have been in successful operation at the Roseland Substation 15 miles from Newark, N. J., for a number of months.

The deion principle applied to air circuit breakers has extended the field of usefulness of that type breaker. A forceful demonstration of this was made during the year when an air circuit breaker was completely shrouded in cotton and a current of 10,000 amp. inter-

[1]See Low Speed Gearless Motor, Electric Journal, May, 1932, page 217.
[2]A Railway Motor Without a Commutator, Electrical Engineering, Sept., 1932, page 650.
[3]Conductor Vibration on Transmission Lines—Electrical Engineering, July, 1932, p. 483 and Aug., 1932, p. 562. Also Vibration in Electrical Conductors, Electrical Engineering, November, 1932, page 795.
[4]Double Conductors for transmission lines. Elec. Engineering, Oct., 1932, page 701.
[5]Hinged Wooden Arms Used on Osage-Rivermines line. Elec. Engineering, Feb., 1932, page 121.
[6]Bottled Nitrogen for Inertaire Transformers. Elec. Journal, May, 1932, page 219.

rupted. The breaker opened with so little generation of heat that the cotton was not even scorched.

Recognition of the part played by gas blasts in interrupting arcs in oil circuit breakers and expulsion fuses has opened new avenues of development in all types of circuit interrupting devices. A recent development in this direction is the boric acid fuse.[7] In this fuse a form of construction is used which permits the interruption of the smaller ranges of current within a device that is capable of interrupting also heavy short circuits up to 20,000 amp. or more. A compressed boric acid liner is used which evolves water vapor. Since this is a condensable gas, it becomes possible to construct a totally enclosed fuse in which the gas blast is discharged into a surface condenser. With such construction, currents of from 5 to 20,000 amp. at 13,000 v. have been interrupted with an electrode separation of less than 6 in.

Lightning and Lightning Protection

The same fundamental investigations which have so markedly extended the field of usefulness of circuit interrupting devices these last few years have also affected the field of lightning protection. Studies of lightning and the effects of lightning on power systems were continued during the year with considerable improvement in the technique of fault location. To aid studies in this field there has been considerable progress in the design of portable surge generators. One of these units, built for use by the Duquesne Light Co., is a 750,000 volt generator which can be fed from an ordinary 110 v. a.c. source. A new lightning generator recently installed at the Ryan Laboratory of Stanford University, producing a 3,000,000 v. surge having 20,000 watt-sec. of energy, is rated among the largest in the world. This unit will be used in making lightning studies preparatory to designing insulation and structures for the transmission lines from Hoover Dam to Los Angeles.

More and more as lightning studies are made, it becomes evident that mere insulation alone will not prevent flashovers from taking place and so other schemes have been devised which do not seek to prevent but rather to control discharges. This, of course, always has been the function of the lightning arrester, but it is only within the past few years that really effective control of the transient current has been obtained. A recent development along this line is the deion flashover protector.[8] This is simply a hollow fibre tube with electrodes at both ends and open at the bottom which is mounted on transmission towers to protect the insulator strings from flashover. One of these units is mounted at each insulator, so that if a surge voltage appears which normally would flash over the insulator, in this case it passes through the protector to ground. The power current which tends to follow, however, is suppressed by the deionizing action of the protector.

Instruments and Measurements

A number of new developments mark the year's progress in the field of electrical measurement and recording devices. Among these one of the most interesting to the transmission engineer is an automatic oscillograph which is intended primarily for the recording of chance and unanticipated disturbances on power systems and in electrical machinery. This device is designed to record a number of disturbances whether the faults follow each other in rapid succession or are days or weeks apart. It starts recording within one-half cycle of the beginning of the initiating disturbance. Less spectacular, but universally useful, is a new direct reading ohmmeter which requires no external electromotive source and which will measure ohms as directly and easily as a voltmeter measures volts. It has resistance ranges of 5000 and 50,000 ohms which are selected by flipping a toggle switch. It uses a 1.5 v. flashlight cell inside the case.

Another development is an accurate bridge[9] for capacitance and low power factor measurements for use on circuits of 10 to 1000 cycles per second. It has a range of measurements extending from insulation samples to power factor correction capacitors. A new field of usefulness has been opened up for the potentiometer by the development of a precision potentiometer of improved design.[10] Previous to the development of this instrument the potentiometer was considered for use solely in high class research and standardizing laboratories. Owing to the low cost and simplicity of operation of this particular instrument, many uses have been found for it in all industrial laboratories, service shops and factories.

A most ingenious development announced during the year was a new highly sensitive photoelectric recorder.[11] Heretofore indicating instruments have usually been considered more sensitive and more rapid than a recording instrument. With the new photoelectric recorder all of the disadvantages of direct acting records are eliminated and we have an instrument that combines all the advantages of direct acting recorders with those of the most sensitive indicating instruments.

An extremely useful application of the photocell and neon tube was made during the year in a stroboscope for testing and calibrating watthourmeters. In this device light impulses are delivered to the photocell by marks on the rotating disc of a "standard" meter, and translated into electrical impulses lighting the neon tube. The light from this tube falling on the rotating disc of the meter to be tested, indicates whether the speeds of the two discs are the same.

Development of high speed relays has continued, resulting in marked improvements to primary power system relays generally and in new developments in the a.c. railway and secondary distribution network system fields.

One of the most important problems in electrical engineering is the development of better insulating materials, and research in this branch of the field has not been neglected during the year. As usual, the work in this line at Johns Hopkins University under the direction of Dr. Whitehead has continued, and he and his associates presented a number of papers before the A.I.E.E. on the subject. In one of these papers by Whitehead and Banos there was announced a most remarkable agreement between loss, power factor and capacity values at 60 cycles for solid and liquid dielectrics as determined experimentally and as calculated

[7]The Boric Acid Fuse. Electrical Engineering, June, 1932, page 411, also Electric Journal, July, 1932, page 345.
[8]The Deion Flashover Protector, Electric Journal, March, 1932, page 131.
[9]A bridge for capacitance and low power factor measurements, General Electric Review, May, 1932, page 295.
[10]A Precision Potentiometer of Improved Design. General Electric Review, March, 1932, page 185.
[11]Photoelectric Recorder has High Sensitivity. Electrical Engineering, Feb., 1932, page 114.

from the d.c. characteristics as obtained by the oscillograph.

Dielectric losses in highly refined insulating oils at commercial frequencies and operating temperatures have been shown to result from conduction but at high frequencies and low temperatures the major loss may be accounted for by the orientation of polar molecules.

Studies of cable oil and impregnated paper cable have gone on and much interesting data is being gathered in many laboratories, particularly in regard to effect of ion bombardment on the oils. The necessity for a completely filled, solid compact cable to prevent internal ionization has been shown. Also, it has been shown that oil pressures of several atmospheres applied to impregnated paper insulated cable give a decided increase in the life of the cable.

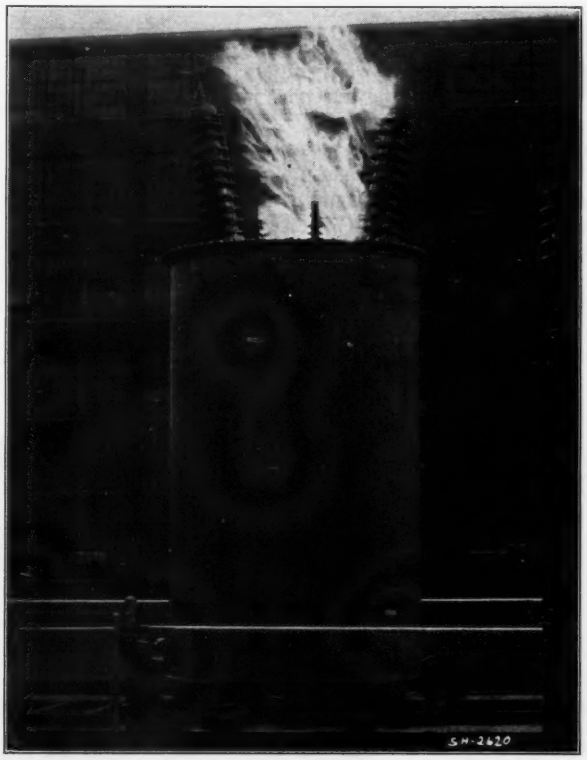
Thermionic Tubes

In no branch of electrical engineering is progress so rapid nor so far-reaching as in the development and application of the thermionic vacuum tube. From the fragile glass "radio" tube it was only a decade ago, it has developed into a real power device, metal clad, and capable of carrying hundreds and even thousands of amperes. Where only a few years ago only a dozen or two different types of tubes were available, today the number of different types runs two hundred or more. While all types of thermionic tubes are of interest, for in their role of relays they are capable of doing almost anything imaginable from counting and grading coffee beans to reversing rolling mill motors, it is in the hot cathode, gas filled type of tube that the power engineer is primarily interested, for it is only this type of tube which is capable of carrying the heavy currents he deals with. These tubes to which the name phanatron has been applied are essentially rectifying tubes. Phanatron tubes in which the starting of the conduction period is controlled electrostatically by the action or one or more grids have been termed thyratrons.

Fundamentally, applications of these tubes may be divided into two classes; i.e., rectifiers converting alternating current into direct current with or without voltage control, and inverters, changing direct current into alternating current. Of course, gas filled arc discharge rectifiers in which the electron emission is furnished by a hot cathode have been available for a number of years, the Tungar and Rectigon being examples of this class. These rectifiers, however, have certain limitations which tend to limit the voltage and current with which they can be used. These limitations are absent at very low gas pressures, between 0.005 mm. and 0.05 mm. and this amount of gas is found to be sufficient to furnish the required positive ions needed to neutralize the electron space charge. The life of the cathode is very short at these low pressures, however, and if operated at normal temperature the efficiency is low. The problem has been solved in the phanatron by providing a cathode of ample size but heated indirectly by a separate heater. Tubes of this kind have carried as much as 6000 amps. They are extremely versatile in their application. In one experimental installation a 12 anode thyratron has been operating with a 3 phase 60 cycle input and delivering single phase 25 cycle. Used as frequency changers, the output frequency of these tubes is independent of the input frequency. If the input frequency varies say between 59 cycles and 61 cycles, on a normal input of 60 cycles, the output frequency remains steady at 60 cycles.

In one instance reported this year a set of such tubes has been furnishing the excitation for a hydrogen filled synchronous converter. Six tubes furnish excitation with perfect control and with greater speed of response than would be possible with equipment having magnetic lag.

One of the new phanotrons, the FG-15, is rated to withstand 20,000 v. peak inverse voltage and to deliver a maximum of 40 amp. An important application of the



A NEW COMBINATION TEST APPLIES A MILLION VOLT SURGE TO A TRANSFORMER WHILE IT IS CONNECTED TO ITS RATED POWER SUPPLY

FH-15 is that of furnishing 20,000 v. d.c. to a 100-kw. pliotron.

These are heavy current tubes. At the other extreme is the new FP-54, a pliotron which has a sensitivity of six electrons per second! This is so inconceivably small that if we consider the six electrons measured by the tube in one second as that many drops of water, then the number flowing in one minute through the usual 50 watt incandescent lamp equals the number of drops in the enormous volume of water going over Niagara Falls in *a whole century!*

Vacuum tube research has stimulated research in other types of rectifiers, particularly the copper-oxide rectifier and their application. By combining these rectifiers with saturated iron core reactors, non-linear circuits can be produced in which the current is caused to flow or stop without any moving parts. Such systems of control can be applied economically to practically all incandescent lamp signs with a reduction in the operating expense of from 40 to 60 per cent.

ELECTRIC SYSTEM *and* GENERATOR PRACTICE

Year's Developments headed by the 200,000 kv-a. Single Cylinder Turbo-alternator at Hudson Ave. Generator Voltages reach 36,000 in Europe.

ONE OF THE MOST important phases of current progress of the electric power industry is the emphasis being placed upon reduction of capital investment per unit of power developed in new apparatus. This has focused attention upon reduction in floor space and in more economical use of material resulting in continued growth in the capacity of individual units. It has also encouraged studies looking to the rehabilitation of existing equipment for greater output and improved efficiency. Particular attention is being directed to the problem of transmission and distribution for it is there that considerable economies can be made, both as regards investment and operation. While construction costs of generating stations have gone down, those of transmission and distribution facilities have gone up. Of course, as those costs have increased, the service refinements and the reliability of our systems likewise has increased, but it is believed that a considerable amount of simplification can be done to bring about a considerable reduction in expenditures. Some of the recognized items that can contribute to these simplifications and economies are,

1. Reduction in number of system voltage levels with the elimination of intermediate transformation.

2. Substitution of higher distribution voltages for the lower distribution voltages where the latter prevail, especially so in extensions to new areas.

3. The increased use of the secondary network system in areas of heavy load density and the extension of the secondary network to overhead duty.

4. The practice of burying underground cable directly in the ground, as has long been the custom in Europe.

5. Simplification of switching equipment and circuit arrangements. While there are other factors these are perhaps the most important and they have received considerable discussion. The cost of power to the consumer to a large extent depends upon the investment involved in transmission and distribution equipment and anything contributing to lower investment costs in this branch of the power industry will reduce the ultimate cost of power.

In the field of electric generation, though the number of new units installed this year is markedly less than in previous years, several notable installations have been made. Of these, the largest is the 200,000 kv-a. 0.8 power factor, 1800 r.p.m. General Electric turbine driven alternator at Hudson Avenue Station. This unit was placed in operation the latter part of January and is one of the two such units being installed. The second unit is now being erected and will be placed in operation in 1933.

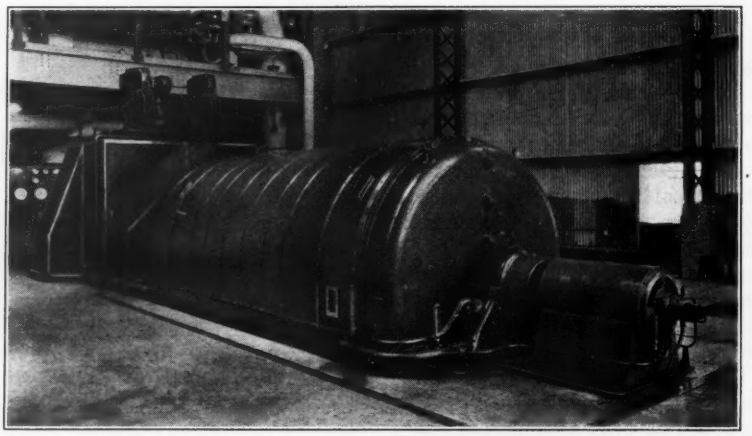
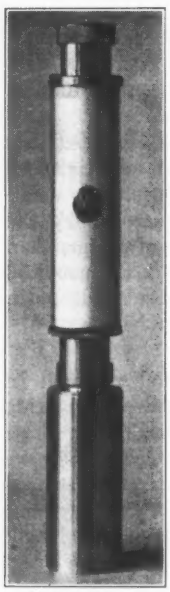


FIG. 1. THE 18,000 KW. HIGH PRESSURE TURBO ALTERNATOR AT BURLINGTON STATION

FIG. 3. THE TYPE FG-52 PHANOTRON, ONE OF THE NEW "POWER TYPE" VACUUM TUBES

FIG. 2. (BELOW) A FUSE WITH A SURFACE CONDENSER



ELECTRIC GENERATOR PRACTICE

STATION	MAIN GENERATING UNITS										HOUSE SUPPLY			
	CAPACITY KV-A.	NO. OF ELEMENTS	SPEED	VOLTAGE	VOLTAGE REGULATION	EXCITATION			COOLING AIR DEG. F		METHOD USED	CAPACITY	ALTERNATIVE METHOD	VOLTAGE
						TYPE EXCITERS	CAPACITY	EMERGENCY EXCITATION	CAPACITY SUB-EXCITERS	IN	OUT				
QUINDARO	1-10,000	1	3,600	13,800	AUTO.	SHAFT	80 KW 250 V.	150 KW. 250V. TURB. DRIVEN	NONE	115	85	OLD PLANT 2300 V. DOUBLE BUS	28,000 KW.	NONE	2300 400
K STREET	2-6,000 KW. AT 0% P.F.	1	3,600	2400/4150 V. Y	AUTO.	SHAFT	2-60 KW. 125 V.	75 KW 125 V. DRIVEN BY 112 H.P. TURBINE	NONE	152 MAX	119 MAX.	THRU REACTORS TO HIGH V. BUS THRU TRANS. TO LOW VOLT. BUS	2-3φ 200 KW 1 TO EA. BUS	NONE	4150 460 / 115
HARDING ST.	2-45,937.5	1	1,800	13,800 V.	MANUAL	MOTOR DRIVE	175 KW. 250 V.	175 KW. 250 V. DUAL DRIVE BY TURBINE & MOTOR	1.5 KW.	127 MAX.	104 MAX.	HSE. ALTERNATOR ON SHAFT OF MAIN UNIT	1750 KW. 2300 V.	1-2500 KV-A. 3φ - 2300 V. TRANS.	440 AND 2,300
CODY	1-3,750	1	3,600	6,900	AUTO.	SHAFT	27.5 KW. 125 V.	25 KW. 125 V.	NONE	?	?	MAIN GENERTOR THROUGH TRANS.	1-300 KV-A. 3φ TRANS.	NONE	460
PASADENA	31,250	1	1,500	16,500	AUTO.	SHAFT	125 KW. 250 V.	2-50 KW. 125 V.	NONE	128	104	MAIN GEN. THRO TRANS. & EMERG'Y. STANDBY UNIT	6-2000 KV-A	NONE	2400
KIDDER	3,750 9,375	1 1	3,600 3,600	2,400 6,900	AUTO. AUTO.	SEPARATE SHAFT	2-50 KW. 45 KW.	ONE OF TWO SEPARATE UNITS	NONE	155	104	MAIN BUS THRO TRANSFORMERS	3-150 KV-A	NONE	2200/440
DODGE CITY	1-6,000	1	3,600	13,800	?	SHAFT	37 KW.	35 KW. MOT. DRIVEN	——	—	—	MAIN GENERTR. THR TRANS.	3-250 KV-A.	FROM 34.5 KV. BUS THROUGH TRANS.	440
HOLLINGSWORTH & WHITNEY	1-3,750	1	3,600	600	?	SHAFT	?	NONE	NONE	NON CONDENSING		NO DISTRIBUTION	TRANSFORMERS USED AT GENERATOR VOLTAGE		
PHILIP CAREY	2-4,700	1	225	2,400	AUTO.	SHAFT	52 KW. 125 V.	NONE	NONE	NON CONDENSING		MAIN GENERATOR THRO TRANS.	3-500 KV-A	NONE	440
PURDUE	NO GENERATING EQUIPMENT INSTALLED														
WEST FARGO	NO GENERATING EQUIPMENT INSTALLED														
RADFORD	1-600 KW. D.C.	1	150	250	?	DIRECT	CURRENT	GENERATORS	NONE	N	N	——	——	——	——
PENNSYLVANIA SUGAR CO.	1-2000 KW. 5 ENGINES TOTALLING 3000 KW.	——	3,600	2,300	AUTO.	?	?	?	NONE	?	?	——	——	——	——
CLARIDGE HOTEL	3-200 KW.	1	400	220	AUTO.	BELT DRIVEN FROM MAIN UNIT	110 V.	NONE	NONE	N	N	——	——	——	——
PILGRIM HOSPITAL	1-781 2-1,500	1 1	133	2,400	AUTO.	1 SHAFT 2 BELT DR.	1-15 KW. 2-25 KW. 125 V.	NONE	NONE	N	N	——	——	——	——
LONGVIEW HOSPITAL	1-250 1-150	1 1	200 225	2300	AUTO.	BELT DR.	?	NONE	NONE	N	N	——	——	——	——
CHASE BRASS & COPPER CO.	NO GENERATING EQUIPMENT INSTALLED														
BRUNSWICK LAUNDRY	1-250 KW. 1-150 KW. 1-700 KW.	1	100	125 V. D.C.	?	——	——	——	——	N	N	——	——	——	——
SPRINGWELLS	2-6,250	1	3,600	4,800	AUTO.	SHAFT	35 KW. 250 V.	400 KW. 250 V. GENERATOR DRIVEN BY 585 HP. 460 V. SYN. MOTOR	NONE	147	100	MAIN GEN. THR TRANS. D.C. AUX. MOT. GENERATOR	2-1000 KV-A 400 KW. DRIVEN BY 585 HP. SYN. MOT.	3 AUX. GEN'S. 625 KV-A. 460 V. ——	460 250
NOTRE DAME UNIVERSITY	NO GENERATING EQUIPMENT INSTALLED														

——EQUIPMENT NOT INSTALLED OR NOT APPLICABLE. ?-REQUIRED DATA NOT FURNISHED. N-NATURAL

Large Size Units

As an example of the concentration of capacity in a single machine may be noted in the new 75,000-kw. single cylinder Westinghouse unit placed in service this year in the Kearny Station of the Public Service Electric and Gas Co. at Kearny, N. J. An excellent illustration of the possibilities of rehabilitation is found in the Burlington Station of the same company where a high pressure non-condensing turbo-generator of about 18,000 kw. was installed, so as to form a new four-cylinder, compound unit of 55,000 kw. capacity. This machine is the largest single cylinder 3600 r.p.m. turbine ever built in this country.

Another large machine now in course of construction is the 165,000 kw. unit for the Richmond Station of the Philadelphia Electric Co. An interesting feature of this installation is that it will fit into a space originally laid out for a 50,000 kw. unit.

Among the generators in the plants listed in the accompanying tabulation the largest are the two at "K" Street and the two at Harding Street.

Generator design has not changed much during the year although here as well as in other fields refinements are being developed. The trend toward the use of higher generator voltages has not exceeded the high point reached early in 1931 when the 31,250-kv-a., 36,000-v. generator was installed at the Langerbrugge power station of the Centrales Electriques des Flanders et der Brabant in Belgium. In this country generator voltages have not exceeded the 22,000 v. used at State Line, Michigan City and Powerton stations. These developments in the use of higher voltages have been brought about largely by the results of extensive researches in the field of electrical insulating materials in recent years; judging from the excellent results of the new insulating materials, 36,000 v., however, is by no means the possible limit of generator voltage.

A similar condition prevails, as regards generator sizes—considerably larger units than those in service at present are possible, provided certain changes are made in generator design. Electric generators built in accordance with conventional design practice are rapidly approaching the limit in size but by the adoption of certain principles of construction and the use of hydrogen cooling, designers claim that units of 375,000 kv-a. are possible.[1] Principal among these proposed changes

is the mounting of one or more synchronous condensers, running free, on top of the generating unit proper. The purpose of this synchronous condenser is to supply all, or a certain amount, of the reactive kv-a. A desirable and economical combination can be obtained by dividing the ratings so that the main generator will be capable of delivering the full kw. rating at 0.9 to 0.95 power factor and the synchronous condenser carry 0.2 to 0.25 of the combined 1.0 kv-a., 0.8 power factor rating. By building such a multiple element generator and using aluminum field coils together with hydrogen cooling, it is said that generating units of 375,000 kv-a. capacity are possible.

In the matter of operation, practice has not changed materially from that laid down in previous years. Voltage regulation is automatic in nearly all cases. Among the stations included in the survey Harding Street station is the only one using manual control. This no doubt is due to the fact that a station such as Harding Street, serving a city directly, has voltage regulators on each of its feeders.

The practice of using sub-exciters has not extended to the smaller type units but as will be noted they are used at Harding Street. The sub-exciter is a small generator mounted on the same shaft as the main exciter, the purpose of which is to furnish field current for the main exciter where quick response is desired.

A careful study of the accompanying tabulation showing data on electric system practice, on the whole indicates little change from practice in previous years. This, however, does not imply that there has been no development, but rather that the development has been along lines which cannot readily be classified. The developments have been largely in the details of equipment used and for this reason they are not reflected in a tabulation such as the one shown. Much of the development, for instance, has been along purely experimental and theoretical lines,—in studies on circuit breakers and other protective devices, in research on insulating materials, in the development and application of new types of relay systems and in many other fields all of which has as its object better performance and reliability.

There has been tremendous interest in the fundamental theories underlying the various circuit breaker developments of the last few years, and this year has witnessed the further application of these principles. Both the oil and Deion principles of circuit breaker construction were extended, the latter to include breakers of 3,000,000 kv-a. capacity.

[1]See Power Plant Engineering May 1, 1932, p. 386.

ELECTRIC SYSTEM DATA

STATION	BUS AND SWITCHING SYSTEM				PROTECTIVE FEATURES				TRANSFORMERS				
	SINGLE LINE DIAGRAM GENERATOR TO BUS	TYPE & VOLTAGE OF CIRCUIT BREAKERS	BUS SYSTEM TYPE	BUS SYSTEM VOLTAGE	REACTORS	RELAYS	GROUND	TYPE LIGHTNING ARRESTOR	TYPE	PURPOSE	CAPACITY	WINDING CONNECTION	POTENTIAL CHANGE
QUINDARO		15 KV. INDOOR SOLENOID OPERATED	CELL	13.8KV.	IN ALL 13.8 KV. FEEDERS	DIFFERENTIAL ON GEN.	UNGROUNDED	STATION TYPE AUTOVALVE ON FDR 13.8 KV.	——	NO TRANS USED. AUX. SYS. SUPPLIED FROM OLD PLANT	——	——	——
K STREET		15 KV. INDOOR SOLENOID OPERATED	OPEN TYPE MAIN & TRANS.	4150	NONE	GENERATOR DIFFERENTIAL OVERLOAD ON FEEDERS	GENERATOR GROUNDED THROUGH 10.4 KV-A. 300 A. 1 1/2% REACTOR	STATION TYPE ON BUS	——	——	——	——	——
HARDING ST.		132. KV. OUTDOOR SOLENOID OPERATED	132 KV. OUTDOOR DOUBLE	132 KV.	NONE	GENERATOR DIFFERENTIAL & TRANSFORMER DIFFERENTIAL	GENERATOR GROUNDED THROUGH REACTOR—	132 KV. AUTOVALVE	OISC	MAIN POWER	6-14,583 KV-A.	Δ-Y	13.2/138 KV.
CODY		15 KV. 600 A. INDOOR SOLENOID OPERATED	OPEN GROUP PHASE	6.9 KV.	NONE	GENERATOR DIFFERENTIAL & OVER CURRENT FDRS.	GEN. UNGROUNDED	NONE-ALL FDR. CUBIC	NONE	——	——	——	——
PASADENA		1600 A. 34.5 KV. OUTDOOR MOTOR OPERATED	HORIZONTAL OUTDOOR	16.5 KV.	16.5 KV. ON GENERATOR	GENERATOR DIFFERENTIAL AND OVERLOAD	GENERATOR GROUNDED THROUGH REACTOR	TYPE SV & LV	OISC	MAIN POWER AT SUBSTATION AND ON DISTRIBUTION	8-2000KV-A 12-1000 KV-A 6000 KV-A	Y Δ AND ΔΔ	16.5/2.4 KV.
KIDDER		INDOOR SOLENOID OPERATED	HORIZONTAL	2.4 KV.	——	——	GENERATOR UNGROUNDED	OXIDE FILM	OISC	MAIN POWER	3-1250 KV-A	Δ Y	2.4/40 KV.
		INDOOR SOLENOID OPERATED	HORIZONTAL	6.9 KV.	IN BUS	GENERATOR DIFFERENTIAL	TRANS. NEUTRAL GRD.	——	OISC AIR BLAST	MAIN POWER	1-9000 KV-A	Δ Y	6.9/40 KV.
DODGE CITY		34.5 KV. OUTDOOR SOLENOID OPERATED	OUTDOOR—	34.5 KV.	NONE	GENERATOR AND TRANS. DIFFERENTIAL PROTECTION	GEN. Y CONNECT. GRD. ED. SOLIDLY THRO. DISCONN.	SV AND THYRITE	OISC	MAIN POWER	3-2500 KV-A	ΔΔ	13.8/34.5 KV.
HOLLINGSWORTH & WHITNEY		?	GROUP PHASE	?	NONE	?	?	NONE	NONE	——	——	——	——
PHILIP CAREY		7.5 KV. METAL CLAD	TOTALLY ENCLOSED VERTICAL BUS	2.3 KV.	NONE	GENERATOR DIFFERENTIAL FEEDER OVERLOAD	UNGROUNDED	NONE — FEEDERS ARE LEAD COVERED, OVERHD. CABLES	OISC	MAIN POWER	3-500 KV-A	Y Y	2.3/4 KV.
PURDUE UNIVERSITY					NO GENERATING EQUIPMENT INSTALLED								
WEST FARGO					NO GENERATING EQUIPMENT INSTALLED								
RADFORD		AIR TYPE 250 V.	GROUP	250	NONE	OVERLOAD	?	NONE	NONE	——	——	——	——
PENNSYLVANIA SUGAR CO.		OIL TYPE	GROUP	2.3 KV.	NONE	?	?	NONE	——	DISTRIBUTION	——	——	——
CLARIDGE HOTEL		AIR BREAK	GROUP	220	NONE	OVERLOAD	?	NONE	OISC	FOR LIGHTING	?	?	220/110 V.
PILGRIM HOSPITAL		OIL TYPE	GROUP	2.4 KV.	NONE	OVERLOAD	?	NONE	OISC	DISTRIBUTION	?	?	2400/240/120
LONGVIEW HOSPITAL		OIL TYPE	GROUP	2.3 KV.	NONE	OVERLOAD	?	NONE	OISC	DISTRIBUTION	?	?	2300/230
CHASE BRASS & COPPER CO.		OIL-TRUCK TYPE	GROUP	4.6 KV.	NONE	OVERLOAD	——	——	OISC	MAIN POWER	7500 KV-A	?	33/4.6 KV.
BRUNSWICK LAUNDRY		AIR BREAK	BACK OF BD.	125 V.	NONE	OVERLOAD	UNGROUNDED	NONE	——	——	——	——	——
SPRINGWELLS		VERTICAL LIFT 15 KV. SOLENOID OPERATED	GROUP	4.6 KV.	Δ 6250 KV-A. & 9375 KV-A. 5% REACTANC	TYPE CA GEN. DIFF. & CR POWER DIRECTIONAL FOR TRANS.	GEN. UNGRD. TRANS. SEC. GRD. THRU 6Ω RESIST	NONE — ALL FEEDERS CUBICAL	OI SF	MAIN & AUX. POWER	1-6250 KV-A 2-1000 KV-A	Δ Δ Δ Δ	23/4.6 KV. 4.6/0.46 KV.
NOTRE DAME UNIVERSITY					NO GENERATING EQUIPMENT INSTALLED								

—— NO EQUIPMENT INSTALLED OR NOT APPLICABLE, ?—REQUIRED DATA NOT FURNISHED, Δ—THESE REACTANCES IN FEEDER CIRCUITS.

Generator Protection

For electric generator protection, the differential scheme of protection as may be noted from the tabulation is practically universal. It is used with all the larger generators. On small generators, particularly the engine driven type, simple overload relays are sufficient. It is in the operation of the transmission systems proper, however, that most of the recent relay developments have been made. More and more, it is being recognized that the effects of short circuits on large systems can be rendered less severe by the use of high speed relay systems which act to isolate the fault before serious damage is done. Where formerly relay timing of one-half to three seconds was satisfactory, now on many of the large high voltage systems it is desirable to remove a short circuit in one-eighth of a second or less. Modern oil circuit breakers will open in a tenth of a second, so with new relays which can be arranged to operate in two hundredths of a second or less, an adequate system of protection can be designed. Aside from the value of these relays in limiting damage done by short circuits, they aid greatly in maintaining the stability of the system. Often these relays operate so rapidly that customers are not aware that trouble has occurred.

An extremely ingenious scheme of protection developed in recent years and one which is finding successful application is the so-called pilot system of protection by power directional relays, using carrier current. Ordinarily with power directional relays the direction or phase of the currents at each or all ends of a protected section are under constant surveillance. Any change in their normal relations indicates a fault somewhere within the section which is immediately detected by the relays and the faulty section promptly isolated. The weakness of this system is that it is unable to distinguish unfailingly between a fault occurring in the protected section and one immediately adjacent to it. To compensate for this deficiency, with the pilot system of protection, additional so-called starting relays are provided whose sole function is to supervise the operation of the tripping relays and prevent tripping if the fault is external to the protected section. The impulses which control the starting relays are carried between various parts of the system by carrier current although in certain cases where the distances are short, separate pilot wires may be used.

This principle of protection is applicable to all types of systems and for all types of faults and provides a system of protection previously obtainable only at great cost. The equipment is comparatively simple and the most elementary form of carrier current is used.

Substations

Considerable progress is being made in the standardization of substation design, both outdoor and indoor. Work in this field has considered such elements as steel structures, foundations, methods of insulating, design of bus structures and disconnecting switches, etc. It is quite evident that many of these elements can be standardized to a certain extent and this will result in decreased costs. Long experience with this class of work has shown that there is a best way of mounting almost every piece of apparatus as well as a best place for it.

As has been the case for many years, the problem of protecting transmission systems against lightning is still an important one, but gradually as studies and research in this field continue, it finds itself closer to solution. In this work the impulse generator or the artificial lightning generator as it is popularly called, has been most fruitful for by its use it has been possible to subject equipment to tests which simulate actual lightning conditions and from the results of these tests to redesign the equipment with the proper factor of safety. This year particular attention has been directed to the design of both power and distribution transformers better to withstand lightning surges. The practical solution of this problem was brought about largely through a better understanding of the distribution of dielectric stresses in the windings. It is spectacular to see a transformer withstand an artificial lightning surge more destructive than those encountered in nature. Their remarkable performance is not a matter of adding more and better insulation between turns and coils. This would help, of course, but the added insulation would be unnecessary and ineffective for normal operation. The answer to the puzzle lies in the design proportions and coil arrangements. In the surge proof transformer the coils are so designed and arranged that the voltage stress is distributed uniformly over the whole winding. An important part of the design also involves a static plate across the face of the first coil to assist the surge in entering the winding and to eliminate padding.

These principles in transformer design were first incorporated in large power transformers but distribution transformers have also been rendered surge proof in a different way, however. These units now are made with air gaps between the high voltage and the low voltage winding and the grounded case. These gaps incorporate features which by the deionizing principle bring about the sudden and sure extinction of the arc after the surge has spent itself.

Although alternating current remains the universal medium for power transmission, direct current is necessary for many applications and for purposes of conversion, the mercury arc rectifier has become increasingly popular in recent years. A notable recent development in this field was the sectional rectifier. A 3000-kw., 650-v. unit of this type consists of four 750-kw. separate rectifiers arranged in a compact unit.

In the field of rectification the new phanotrons and thyratrons undoubtedly are destined to play an important role. Although no large "power" applications of these "hot cathode" tubes have been made, all the experimental work seems to indicate that in the future they will be used for such purposes. For years electrical engineers have dreamed and toyed with the idea of high voltage direct current transmission but until the development of these tubes their dreams were always far from any possibility of realization. With these new tubes, however, capable of handling hundreds and even thousands of amperes, of converting alternating current to direct or vice versa, or of changing the frequency, it is quite possible that for certain purposes at least, high voltage direct current transmission may become possible not so many years hence. Already as mentioned elsewhere in this issue, such tubes are being used to furnish excitation current for a large outdoor hydrogen filled synchronous condenser, and in Boston a small installation of such rectifiers has been in successful operation for over a year.

POWER PLANT ENGINEERING January 1933

DIESELS *Make Notable* ADVANCE *During the Year*

Automatic Diesel, 35,000-kw. Municipal Plant, 22,500 hp. engine and Further Development of High Speed Diesels but a few of the year's developments.

IN SPITE OF a material decrease in the total output of Diesel engines during the past year, the field of application has been materially increased. This is particularly true of municipal and small industrial plants, a large portion of the units installed being on the "pay out of savings" basis. This form of marketing has played an important role in financing new construction and is of equal importance with any of the technical developments.

Another factor of importance in marketing engines is the rumored introduction of maintenance and supervision clauses in the contract guaranteeing that these items will not exceed a certain maximum. Based upon reliable long time operating records, this practice is perhaps safe enough from a business standpoint if viewed in the same light as a well diversified insurance business. Apparently in some cases fuel oil prices have also been guaranteed not to exceed a definite maximum and it is difficult to believe that such a gamble is fundamentally sound business practice.

Automatic Operation

Aside from these developments in marketing to meet present business conditions, there have been a number of technical developments of more than usual interest. Perhaps the most important of these is the further extension of the automatic Diesel plant in One Park Avenue where four 270-hp., 360 r.p.m. engines, driving 180-kw. direct current generators will be automatically controlled similar to the Hotel Chelsea installation described last year. A storage battery is used in connection with the plant to carry increased load until another engine unit starts. This installation is in an 18 story office building with 20 elevators.

Central Station Use

If carried to its ultimate development, this type of plant opens up an immense field for the new small medium and high speed engines quite as important to the industry as the installation of the 22,500-hp. unit for Copenhagen, Denmark. This latter is an eight cylinder (840 by 1500 mm. or 33 by 59 in.) 115 r.p.m., double acting two cycle solid injection engine driving a 15,000 kw. generator. At 12,500 kw. the fuel consumption guarantee is 0.53 lb. per kw. hr. The manufacturers feel that a 12 cyl. engine of the same construction operating at 187 r.p.m. could safely develop 40,000 b.hp. which of course definitely places the Diesel in the large central station field.

In fact the municipal installation at Vernon with five 7000-hp. engines has already placed the Diesel in this field and the performance of this installation will be watched with interest throughout the engineering world. These units are 8 cylinder 24 by 36 in., double acting solid injection, two cycle engines, running at 167 r.p.m. and driving 5000-kw. generators. Scavenging air is supplied by motor driven blowers.

Refrigeration Drive

In the refrigeration field a new development is the hybrid Diesel with the engine and compressor cylinders on the same frame. All types of Diesel engines have made headway in this field, one of the recent installations being at Huntington, N. Y., where one 320 hp. engine driving a 10 by 10 in. and a 11 by 13 in. vertical, twin, single acting compressors and a 60 kw. belted generator is installed. The 11 by 13 in. compressor can be disconnected on lighter loads. A 65 hp. engine driving a 7 by 7 in. compressor and a 20 kw. generator can be used for very light loads. An oil consumption of 3½ gal. per ton at 65 t. capacity and 4¼ gal. of oil per ton at 45 t. is reported.

Important installations are given in the accompanying table with detailed data. Many others are planned, one of the most interesting being a 2100 kw. unit in the Union Stock Yards, Chicago. This unit will be installed between two turbines and will operate in conjunction with the present steam plant and purchased power.

Fuel oil consumption figures in this year's plants range from 10 to 13.5 kw. hr. per gal., approximately the same range as previously. Increased attention is also being paid to the purification of lubricating oils, fuel oils and air. Both closed and open cooling systems are widely used, the tendency being to use lower water temperatures leaving the cylinders, although this is determined largely by local weather and water conditions, beyond the designer's control.

Manufacturers seem to feel that there will be continued development of smaller size engines and an increased tendency toward lighter weights, higher speeds and more nearly automatic control. Alloys are being used extensively to reduce weight and welding has helped materially in cutting both construction costs and finished weights.

DIESEL PLANT DATA

PLANT	LOCATION	KIND OF SERVICE	NO. AND HP. OF ENGINES	NO OF CYLINDERS	CYL SIZE IN.	SPEED R.P.M.	FULL LOAD M.E.P	FUEL INJECTION	CYLINDER AIR COMPRESSOR	FUEL					OIL PURIFICATION		COOLING WATER						TYPE AIR FILTER	EXHAUST TEMP. DEG. F	TYPE MUFFLER	TYPE OF EQUIPMENT DRIVEN
													STORAGE				SOURCE OF SUPPLY	TREATMENT		METHOD OF COOLING	TYPE OF SYSTEM	TEMP °F					
										GRAVITY A.P.I	B.T.U. PER GAL	KW-HR. PER GAL 3/4 LOAD	TYPE AND LOCATION	CAP. GAL	FUEL	LUBRICATING		TYPE	GAL/DAY			IN	OUT				
PUBLIC SERV. CO OF COLO.	STERLING COLORADO	CENTRAL STATION	1-2750 ▲	10	19½X27	240		SOLID	CENTRIF COMP.	22-32	143,500	13.3 NET	2 STEEL UNDERGRND.	25,000	CENTRIFUGE STRAINERS	CENTRIFUGE STRAINERS	WELLS	PHOSPHATE	9000	TOWER	CLOSED	90	120	FIBER	400-3/4 LD	BAFFLE	2300 V 3Φ, 60~ 2812 KV-A GEN & EXCITER
IOWA ELEC. CO.	ANAMOSA, IA.	CENT. STA.	1-510	6	14 X 21	277		SOLID	NONE	24-28			STEEL TANK ABOVE GRD.	12,000	———	———	RIVER	———	———	RIVER	CLOSED	90	150	———	750	———	A.C. GENERATOR
ROCKVILLE CENT.	NASSAU CO. N.Y.	MUNICIPAL	1-2865 ▲	8	29X48	120		AIR	DIRECT CONNECTED COMP.	20			STEEL TANK ABOVE GRD.	60,000	———	SETTLING & CENTRIFUGE		NONE	NONE	TOWER	OPEN	90	120	FIBER		MULTIPLE UNIT TYPE	2300 V. 2500 K.V.A. GEN. & EXCITER
NEW CASTLE MUNICIPAL	NEW CASTLE IND.	CITY WATER & ST LIGHTS	1 500 1 750	4 6	17½X24	240	71.2	SOLID	———	28-30			STEEL TANK ABOVE GRD.	18,000	NONE	CENTRIFUGE	WELLS	ZEOLITE		TOWER	CLOSED			FIBER		MULTIPLE UNIT	2300 V. 3Φ. 60~ GENERATOR
ROCKINGHAM MILLING CO.	HARRISBURG VA.	MILL	1-162	3	12 X 15	360		SOLID	———	28		10	TANK	10,000		FILTER				TOWER		95	110		350	MULTIPLE UNIT	220 V. GENERATOR
WESTERN PUB. SERV. CO.	CHADRON NEB.	CENTRAL STATION	1-1500	5	19½X27	240		SOLID	RECIP.	32-34	147,590	11.78	STEEL TANK ABOVE GRD.	24,000	STRAINER	CENTRIFUGE	CITY	LIME & SODA ASH	57,600	TOWER	OPEN	70	80	FIBER	470	CAST IRON	2300 V 3Φ 60~ GEN & DIRECT CONN EXC
WESTERN PUB. SERV. CO.	SIDNEY NEB.	CENTRAL STATION	1 1200	8	16 X 20	257		SOLID	RECIP.	32-34	147,590	11 50	STEEL TANK UNDERGRD	24,000	STRAINER	CENTRIFUGE	WELLS	NONE	———	———	OPEN	60	70	NONE	500	UNDERGRD CONCRETE PIT	2300 V. 3Φ. 60~. GEN. & DIRECT CONN. EXC.
WESTERN PUB. SERV. CO.	OGALLALA NEB	CENTRAL STATION	1-1050	7	16 X 20	257		SOLID	RECIP.	32-34	147,590	11.50	STEEL TANK ABOVE GRD.	24,000	STRAINER	CENTRIFUGE	WELLS	NONE	———	———	OPEN	60	70	NONE	500	UNDERGRD CONCRETE PIT	2300 V 3Φ 60~ GEN & DIRECT CONN. EXC
WESTERN PUB. SERV. CO.	ORLEANS NEB.	CENTRAL STATION	1-1050	7	16 X 20	257		SOLID	RECIP.	32-34	147,590	11.50	STEEL TANK ABOVE GRD.	24,000	STRAINER	CENTRIFUGE	CITY	ZEOLITE		TOWER	OPEN	80	90	NONE	500	UNDERGRD CONCRETE PIT	2300 V. 3Φ. 60~. GEN & DIRECT CONN. EXC.
CITY OF VERNON	VERNON CAL	MUNICIPAL	7-7000	8	24 X 36	167	73	SOLID	BLOWER																		5000 KW. 7200 V. 3Φ 60~ GENERATOR
TUCSON GAS EL. LGT. & P. CO.	TUCSON ARIZONA	CENTRAL STATION	1-4100		30X 42	124	73	SOLID	BLOWER	19	144,000	13.50	STEEL TANK ABOVE GRD.	35,000	NONE	CENTRIFUGE	WELL	ZEOLITE	60,000	TOWER	OPEN	90	120	AIR WASHER	550	UNIT SILENCER	2300 V. 60~ 3Φ GENERATOR
MO SERVICE CO	TARKIO MO.	CENTRAL STATION	1-1050	7	16 X 20	257		SOLID	SCAVENGING CYLINDER	32-36	147,590	10.50	4 METAL TANKS ABOVE GRD.	48,000	STRAINER	———	WELL	RAIN & STM. HT. RETURN	NONE	HT. EXCH. OR TOWER	CLOSED	85	90	NONE	520	PIT	906 KV-A 2300 V 3Φ 60~ GEN
GREAT LAKES PIPE LINE CO.	BARNSDALL OKLA.	PUMP STA.	2-330	6	14 X 16	270	65	SOLID		26-32	18,000	19.10	STEEL TANK UNDERGROUND	42,000	STRAINER	FILTER	CITY	ZEOLITE	1700	TOWER	OPEN	90	120	DRY	375	NONE	5 3/4 X 24 RECIP PUMP
"	INDEPENDENCE KANSAS	PUMP STA.	2-330	6	14 X 16	270	65	SOLID		26-32	18,000	19.10	STEEL TANK UNDERGRD.	42,000	STRAINER	FILTER	WELL	ZEOLITE	1700	TOWER	OPEN	90	120	DRY	375	NONE	5 3/4 X 24 RECIP. PUMP
"	HUMBOLDT KANSAS	PUMP. STA.	2-330	6	14 X 16	270	65	SOLID		26-32	18,000	19.10	STEEL TANK UNDERGRD.	42,000	STRAINER	FILTER	CREEK	ZEOLITE	1700	TOWER	OPEN	90	120	DRY	375	NONE	5 3/4 X 24 RECIP. PUMP
"	KANSAS CITY KANSAS	PUMP STA.	2-330	6	14 X 16	270	65	SOLID		26-32	18,000	19.10	STEEL TANK UNDERGRD	42,000	STRAINER	FILTER	WELL	ZEOLITE	1700	TOWER	OPEN	90	120	DRY	375	NONE	6 X 24 RECIP PUMP
"	OSCEOLA, IA.	PUMP. STA.	2-330 1-120	6 3	14 X 16 12½X16	270 250	65 65	SOLID		26-32	18,000	19.10	STEEL TANK UNDERGRD.	42,000	STRAINER	FILTER	RESERVOIR	ZEOLITE	1700	TOWER	OPEN	90	120	DRY	375	NONE	5 3/4 X 24 4 1/4 X 12 RECIP. PUMP
"	GRINNELL IA.	PUMP. STA.	2-170	3	14 X16	270	65	SOLID		26-32	18,000	15.40	STEEL TANK UNDERGRD	42,000	STRAINER	FILTER	WELL	ZEOLITE	1000	TOWER	OPEN	90	120	DRY	375	NONE	4 5/8 X 18 RECIP. PUMP
"	CORNING IA.	PUMP STA.	1-120	3	12½16	250	65	SOLID		26-32	18,000	15.40	STEEL TANK UNDERGRD.	42,000	STRAINER	FILTER	WELL	ZEOLITE	190	TOWER	OPEN	90	120	DRY	320	NONE	4 1/4 X 12 RECIP PUMP
"	MUSKOGEE OKLA.	PUMP STA.	1-120	3	12½X16	250	65	SOLID		26-32	18,000	19.10	STEEL TANK UNDERGRD	42,000	STRAINER	FILTER	WELL	ZEOLITE	190	TOWER	OPEN	90	120	DRY	320	NONE	4 1/4 X 12 RECIP. PUMP

▲ OTHER STEAM OR DIESEL UNITS IN STATION

Progress in HYDRAULIC POWER *Development*

DESPITE THE unfavorable economic conditions prevailing throughout the world there has been considerable activity in the hydraulic power field during the year. A number of new developments were completed and placed in service and construction work on others started, some of considerable importance. There has been keen interest in the engineering and technical aspects of hydraulics and many studies and investigations are under way by which it is hoped efficiencies may be improved and reliability increased. The efficiency of hydraulic turbines, however, has reached such a high value that further increases in efficiency to be expected are small. With hydraulic turbine efficiencies of almost 94 per cent it is obvious that the opportunity for further improvement is small. Because of this designers today are more concerned with improving the efficiency of hydraulic turbines over a wide range of load rather than with the gain of a small fraction of a per cent at rated load. This accounts for the growing popularity of the Kaplan turbine for this type of turbine is particularly adapted to carry swinging loads without serious loss in efficiency. At the present time Kaplan turbines are limited to heads of about 100 ft. but it is possible that these limits will be raised as knowledge of the cause of cavitation is increased.

The maintaining of the proper balance between hydroelectric and steam power on systems having both types of plants is an intricate problem and a great amount of study is being devoted to it. The carrying of peak savings on hydroelectric plants results in reducing kilowatt-hours of output that could have been generated in operating the plant at a uniform discharge just equal to the river flow. At the same time this sacrifice is usually more than made up by the assistance it renders to the steam system.

In the operation of systems having both hydro and steam stations there is an increasing appreciation of the fact that the incremental cost per kilowatt of hydro development compares favorably with that of steam and so with the growth of power systems and increasing sharpness of the peaks that must be carried as a part of the duty of a public utility to its customers, we may look to hydro as a means of securing a limited amount of peak capacity.

Fundamental Records

Much attention is being accorded the various details which go to make up hydraulic plant practice. The various committees of the technical societies are at work investigating such matters as specifications for concrete used in the construction of dams, the testing and further development of instruments for the measurement of water flow, in the lubrication of submerged parts of hydraulic turbines, in the long time forecasting of water supply by cyclic analysis and many other matters. Particular interest is being given the question of cavitation, and a laboratory especially designed for studying this problem has been developed. At the same time at the Massachusetts Institute of Technology an extensive series of tests is being conducted to determine the fundamental principles that govern the phenomenon. As intimated above, with the development of high specific speed propeller turbines such as the Kaplan turbine, cavitation becomes a limiting factor affecting the design and unless guarded against, may result in severe damage to the runners. The most notable contribution to the solution of this problem this year was a paper presented at the spring meeting of the hydraulic power committee of the N.E.L.A. by Prof. Wilhelm Spannhake of the Technische Hochschule, Karlsruhe. In this paper Prof. Spannhake presented a clear and illuminating discussion of the subject and indicated possible methods of solution. In the tests at the Massachusetts Institute of Technology special attention is being given to a study of pressure distribution in the zone of cavitation, the formation and collapse of the cavitation bubbles by spark photography and the influence of cavitation on various metals.

Important Developments

Among the new hydroelectric developments in progress, in point of sheer magnitude, of course, the Boulder Canyon project tops the list. The Hoover dam is so much larger than any other ever built that one's imagination is strained to conceive it. Construction work on this project has been pushed at a rapid rate and the contractors are fully six months ahead of their required progress and are planning to construct the cofferdams and divert the Colorado River through the diversion tunnels during the winter (1932-33), one year ahead of the date originally contemplated. The principal work accomplished so far is the excavation of the four 56 foot diameter diversion tunnels. These are lined with 3 ft. of concrete.

Undoubtedly the most outstanding large development of the year was the Safe Harbor plant which in addition to having the most powerful Kaplan turbine in the world is unique in many other respects. Operation is reported as satisfactory, though tests are still being made.

A small development that attracted considerable

attention during the year was the Eagle Pass development[1] of Eagle Pass, Texas. This plant has installed in it three 477 hp. turbines with Francis runners which on tests conducted at the plant gave an average efficiency for the three units of 93.46 per cent. Unit No. 3 alone developed 93.9 per cent efficiency at the best point of the load curve. This same unit showed an overall efficiency of 90.7 per cent from the water level in the forbay to switchboard energy.

This year was also marked by the opening of the first hydroelectric power development on the Columbia River. This project, the Rock Island Development, is located east of the Cascades on the Columbia River in Central Washington about 13 miles downstream from Wenatchee. The initial installation consists of four vertical shaft units rated at 21,000 hp. at 32 ft. head. The wheels are of the propeller type with adjustable vanes, selected because of the low and varying head conditions. They constitute one of the largest installations of this type in the United States. It also is the first major low head installation on the Pacific Coast, a territory long famous for its high head plants. The power house is built into the dam and while the present building will accommodate only the initial four units, the foundations are in for the ultimate twelve units. The ultimate installation will require a building 880 ft. long.

The Rock Island development, according to a report made to the Secretary of War this year, is one of ten sites, which, if developed, could supply 8,000,000 kw. The total cost of these developments, exclusive of Rock Island, is estimated at about $740,000,000.

Foreign Plants

Aside from these plants in the United States a number of other important plants have been built in other countries. In Europe, several large plants have been built along the Rhine. One of these which attracted considerable attention was the Ryburg-Schworstadt plant, placed in service in 1930. This plant was notable because it was the first plant in which Kaplan turbines of large capacity were used. At the present time another large plant of similar design is under construction, the Dogern[2] Plant. This plant is quite similar to the Ryburg-Schworstadt plant and will have three Kaplan turbines rated at 37,600 hp. each. These units are exactly the same size as those installed in the Ryburg-Schworstadt plant.

These plants are of considerable interest because they form part of the general scheme of hydroelectric development on that portion of the Rhine between Germany and Switzerland. Between Schaffhausen and Bale, within a length of 85 mi., the Rhine has a total drop of 520 ft. This head will ultimately be utilized by 13 developments of which 5 are already built and one, the Dogern, is now under construction.

A development of an entirely different type and situated in an entirely different part of the world from the Rhine plants is the Fusenko Power Plant in Korea, which is the largest water power development in the far east. This plant is located on the Fusenko River which has its source in the territory of the Fusenrei mountains in the neighborhood of the Japanese Sea at an altitude of about 6000 ft. The development includes a reservoir extending over an area of 9.3 sq. mi. and having a storage capacity of approximately 25,000 million cu. ft. As a result of this storage, a constant flow of 600 gal. per second is always available for power generation.

It is because of the Pelton wheels installed in this plant that it is particularly notable. They are probably the largest Pelton wheels in the world. Four of these units were installed by Messrs. J. M. Voith of Heidenheim a.d. Brenz (Wurttenburg, Germany). They are each fitted with two nozzles, working under an effective head of 2180 ft. and develop 50,000 hp. with 1280 gal. of water per second and at 360 revolutions per min.

This practice of building impulse wheels with multiple nozzles is quite common practice in Europe and in this respect differs considerably from American practice. In this country the usual practice is to make single-nozzle runners and to obtain large powers by using two overhung wheels with the generator between. In Europe two nozzles per runner are common and frequently two or three of the latter are mounted on the same shaft but they are always placed close together and on the same side of the generator. A number of the vertical turbines of the Pelton type have also been constructed, some with four nozzles.

The official opening of the hydroelectric power station on the Dnieper River, known as Dnieprostroi took place on October 1. The first unit was put in operation on May 1st and another four have been finished and gradually tested since then.

Hydraulic Laboratory Progress

Several important events in the field of hydraulic laboratory practice mark the year's progress. First among these was the completion of the National Hydraulics Laboratory at the Bureau of Standards at Washington, D. C., and the initiation of the first experimental projects. About 20 research problems have been submitted to the laboratory by several bureaus of the Federal Government for study at the earliest possible date. These include an investigation of the loss of head at bends in large pipe lines, the study of means for preventing the silting of an irrigation ditch reservoir, methods and appliances for measuring the depths of swift and deep rivers, the effect of turbulence on current meter ratings and many other problems.

Another new hydraulic laboratory is the one at Tulane University of Louisiana at New Orleans. While this laboratory is equipped to illustrate and teach the fundamentals of hydraulics, it is available for a wide range of research problems which the equipment and personnel will permit.

Other new hydraulic laboratories are the ones at The University of Tennessee and at the Newport News Shipbuilding and Dry Dock Company. The later is in course of construction and will be ready for use in March, 1933.

An interesting feature in connection with the Eagle Pass turbines was that the high efficiency attained was largely the result of the surprisingly high efficiency attained by the commercial-size model tested in the Holyoke flume.

[1]Eagle Pass Hydroelectric development, Aug. 1, 1932, Power Plant Engineering page 583. Also see December issue, page 821.
[2]Dogern on the Rhine, Power Plant Engineering, November, 1932, page 774.

Fifty-third Annual Meeting of the A. S. M. E.

ANNUAL MEETING HELD IN NEW YORK, DECEMBER 5 TO 9. HAS A TOTAL REGISTRATION OF 2050. A. A. POTTER, DEAN OF THE SCHOOLS OF ENGINEERING, PURDUE UNIVERSITY, PRESIDENT FOR 1933

DISPLAYING a spirit of earnest coöperation such as old-timers say has not been equalled for many years, the fifty-third annual meeting of the A.S.M.E. was a rousing preview of the coming year. At both the A.S.M.E. meeting and the Power Show there was an undercurrent of conservative optimism indicating that the coming year promises an upturn in the business curve. Registration totalling 2050 was a trifle above last year's attendance. Meetings were well attended with lively and numerous discussions while the unusually good weather made the excursion trips popular.

A. A. POTTER

On Tuesday night President Conrad N. Lauer spoke on Unifying the Engineering Profession, the importance of which is constantly increasing with the complexity of our modern civilization and the more active entry of the engineer into public life. At the same meeting the election of new officers was announced as: A. A. Potter, president, J. D. Cunningham, H. V. Coes, and C. F. Hirshfeld, vice-presidents, and R. L. Sackett, J. A. Hunter and Alex D. Bailey, managers.

Four of these men are from the middle west and have played such an important part in the power industry that an introduction is hardly necessary. A. A. Potter is dean of the Schools of Engineering of Purdue University, Lafayette, Ind.; Alex D. Bailey is superintendent of generation stations of the Commonwealth Edison Co., Chicago, Ill.; C. F. Hirshfeld is chief of the research department of the Detroit Edison Co., Detroit, Mich., and J. D. Cunningham is president of the Republic Flow Meters Co., Chicago, Ill.

The remaining three men although not so well known in the power field have been prominent in engineering and educational fields and in society affairs for many years. H. V. Coes is manager of the industrial department of Ford, Bacon & Davis, Inc., New York, N. Y.; R. L. Sackett is dean of the school of engineering of Pennsylvania State College, State College, Pa., and J. A. Hunter is professor of mechanical engineering at the University of Colorado, Boulder City, Colo.

AWARDS

Following the introduction of President-Elect Potter the following awards were conferred for 1932 papers: Melville Award to Dr. Alexey J. Stepanoff, Byron-Jackson Pump Co., for his paper on Leakage Loss and Axial Thrust in Centrifugal Pumps; Charles T. Main Award to Marshall Anderson, University of Michigan, for his paper, Apprenticeship and Vocational Training; Junior Award to Edmond M. Wagner, Stanford University, for his thesis Frictional Resistance of a Cylinder Rotating in a Viscuous Fluid Within a Coaxial Cylinder; Student Awards to (1) H. E. Foster, Jr., University of Tennessee, for his paper, Factors Affecting Spray Pond Design and (2) William A. Mason, Stanford University, for his paper on Flame Propagation in Internal Combustion Engines.

The high quality of this year's program is reflected not only by the above award papers but by the Henry Robinson Towne lecture on Tuesday and the Robert Henry Thurston lecture on Thursday. The former, on the Scientific Approach to Human Affairs, was delivered by A. W. Robertson of the Westinghouse Electric & Mfg. Co., and Chairman, by appointment by President Hoover, of the Committee on Rehabilitation of Industry. In the course of the lecture he developed the thought that all of life's activities should have exact knowledge comparable to the knowledge in the field of physical sciences. The second lecture, by Dr. W. F. G. Swann, director of the Bartol Research Foundation of The Franklin Institute, dealt with recent advances in physics and was perhaps a challenge to Mr. Robertson's lecture, showing how far the scientist has progressed in his own field and how much of this knowledge has been applied by the engineer.

TECHNICAL SESSIONS

On the technical part of the program approximately 65 papers and professional division progress reports were presented at 28 technical sessions. Of these, seven sessions were of special interest to power engineers. The Diesel engine field was represented by two papers, one on Diesels for Small Boats, by A. B. Newell, of Motor-

ship and the other the annual progress report of the Oil and Gas Power Division.

Hydraulics and Fluid Flow

In the hydraulic field three papers of fundamental importance were presented in two sessions on Wednesday. At the first, Wilhelm Spannhake, Visiting Professor of Hydraulics at Massachusetts Institute of Technology, reviewed the present status of design principles which applied equally to centrifugal pumps and hydraulic turbines. The fundamental ideas underlying the theoretical behavior of a runner with an infinitely large number of blades was built up and the resemblance between the blading ordinarily used and the wing of an airplane brought out. The final section of the paper dealt with the best conditions for the design of high speed runners, discussed the principal figures of layout on which both efficiency and cavitation depend and gave complete curves for the efficiency and cavitation coefficient for three different specific speeds.

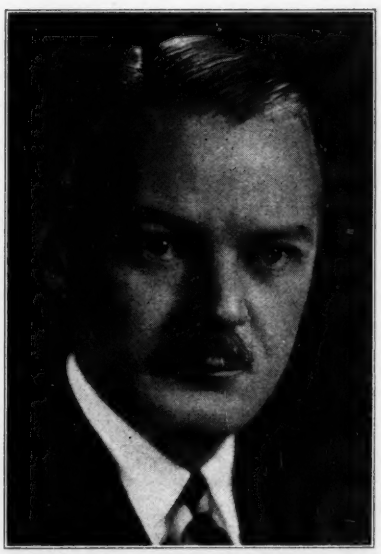
Water meaurement is of extreme importance in hydraulics and at the same session a paper by Hunter Rouse, Massachusetts Institute of Technology, told what had been done in flow measurement at the Research Institute for Hydraulic Engineering and Water Power in Germany. Comparative test results by weir, current leader, pitot tube, Gibson method and Allen salt-velocity methods of testing brought forth a flood of discussion. Apparently each method when used in its proper field by experienced operators will give equally satisfactory results.

At the second Hydraulic Session Emory Kemler, University of Pittsburgh, presented a study of the data of the flow of fluids in pipes in which he reduced early experimental work in this field to the Reynolds dimensional basis. The friction factor is independent of the fluid flowing for the same value of Reynolds number and the importance of this index in fluid flow is rapidly being recognized.

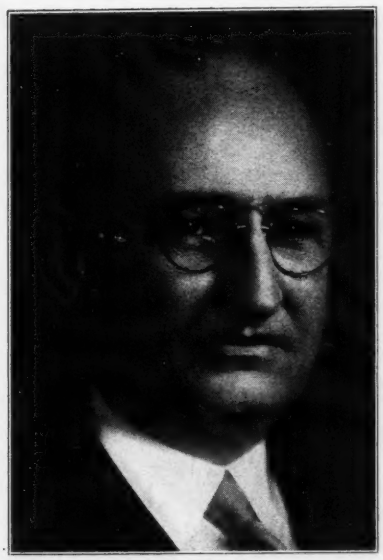
In the field of engineering it is felt that recognition be given to those who deserve it and considering the importance of the part played by the late John R. Freeman, in hydraulic engineering, it was quite appropriate that he be paid a tribute at the meetings of the society in which he took such an interest. Early in the year Dr. Freeman was elected to honorary membership in the society but died before this honor was formally conferred upon him. The presentation was made posthumously on President's night.

Steam Power

Steam power interests were divided between three sessions, the first an extremely important one, being the public hearing of the power test code on Monday afternoon. The test code for centrifugal compressors, exhausters and fans, was well received and apparently filled a long-felt need. This code was based on a tentative draft formulated jointly by the A. S. H. & V. E. and the N.A.F.M. in 1923. This preliminary draft was revised by the same group early in 1932 and again revised this fall in coöperation with the A.S.M.E. Power Test Code Committee.



J. D. CUNNINGHAM



H. V. COES

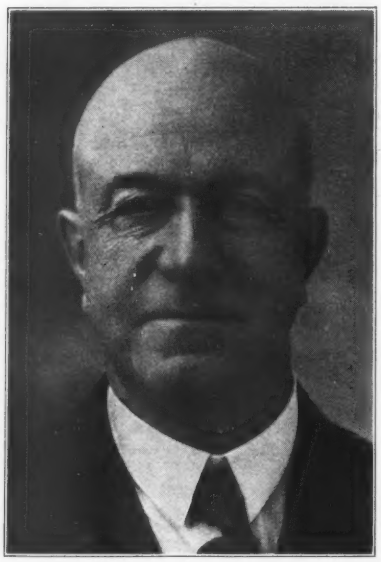
C. F. HIRSHFELD

As formulated, the code is an important step but that much work remains to be done on this general subject both for tests and installation purposes was indicated by two papers presented at the same session. Harold F. Hagen, B. F. Sturtevant Co., analyzed errors that result when a pulsating velocity exists. A velocity wave is accepted without question with reciprocating machinery and means taken to eliminate the pulsation. It has been assumed, however, that a fan rotor gives a steady flow and fan testing has been based unquestionably upon this supposition. As a matter of fact, actual pulsation seems to exist in all fans although the amplitude of the wave is often so small that noticeable errors in measurement do not occur. In other cases, the amplitude is sufficiently large to make wide differences, ranging in tests quoted, as high as 18 per cent.

Discussion brought out the point that errors are a function of both the amplitude and frequency of the pulsation and that the vibrations shown in the paper could not in themselves have caused errors of the mag-

nitude mentioned. It seemed to be felt that the major part of the errors was probably due to turbulence and pitot tube location. To this Mr. Hagen replied that the term pulsation was used in a somewhat general way to include all factors that seemed to cause erroneous pitot tube readings. The point which he wished to bring out was that pitot tube and nozzle readings taken simultaneously often disagree, a fact that should be covered by the test code.

Proper installation of the fan is also extremely important from the efficiency and capacity standpoint. L. S. Marks, J. Lomax, and R. Ashton, all of Harvard University, presented a great deal of experimental data showing the effect on fan performance from elbows and bends close to the inlet boxes. The loss is a function of the type of bend, its aspect ratio or ratio of depth to width, and of the direction in which the air is turned in the bend. The cause of the lost capacity is not due to friction in the bend but is due to the poor distribution of air entering the inlet box. By the use of guide vanes in the bend or scroll inlet boxes provided with guide vanes, practically all loss can be prevented. The use of a short length straight duct between the bend and inlet box will also materially reduce capacity loss.



R. L. SACKETT

J. A. HUNTER

ALEX D. BAILEY

Industrial Power

On Tuesday morning there was a session devoted to industrial power. The first paper by Carl C. Thomas, California University of Technology, gave a description of the equipment used and some of the observations made on the problems of sampling wet steam and separating the moisture from it. The work consisted of the observation of steam flow in illuminated steam passages and the comparative calorimetric and separating determinations of free moisture traveling with the steam. Results indicate that wet steam cannot be accurately sampled by sampling tubes and that water should be separated as completely as possible and measured independently for quality determination. The author is inclined to believe that steam which appears to be transparent when strongly illuminated is dry steam. Work is now in progress to test the soundness of this belief.

Discussion verified the general statement of Mr. Thomas that present code sampling equipment is not reliable and the interest in further investigations of the same type shows what an important factor wet steam, its determination and elimination, is to the power field.

The second paper of the industrial power session was a progress report of high-pressure steam generator research made by the special Research Committee on Critical Pressure Steam Boilers. The report was presented by H. L. Solberg, G. A. Hawkins and P. A. Willis, all of Purdue University, where the steam generator is installed. Investigations carried on since January 1, 1932, were mainly concerned with the measurement of the enthalpy of steam by the use of a condensing calorimeter designed for pressures up to 3500 lb. per sq. in. The heat leak of the calorimeter was determined by assuming that the Keenan tables were correct within the range in which the calorimeter was calibrated. Thirty-nine tests of pressures from 1900 to 3500 lb. and 709 to 780 deg. F. were carried on. Results were compared with those of other investigators and agree with the majority of them, although there is considerable variation from Callendar's results.

This paper was also discussed at the Steam Tables Research Session on Wednesday at which progress of investigations of the thermal properties of steam at Massachusetts Institute of Technology, Bureau of Standards and the Masaryk Academy of Work in Prague were reported. From this work steam tables are being extended and gradually filled in, in the regions now more or less unknown.

Heat transmission and stokers were combined in one session on Tuesday afternoon. Measurement of metal temperatures on the heat receiving side of heat exchange apparatus is of extreme importance in the modern plant because of the high pressures and temperatures used and the fact that this equipment frequently involves the use of extremely high metal temperatures. The method of determining the temperature of these metal walls under operating conditions with thermo couple wires

attached to the outside wall were told by Arthur Williams, of the Superheater Co., in the first paper of the session. Details of the methods to be used for tests of this kind, precautions that must be taken, calibration of thermo couples, was given in great detail.

Experience gained from nearly three years' operation of the large single-ended stokers at Detroit has led to developments and improvements in design, the application of which is made comparable with other types of coal burning equipment, according to Paul W. Thompson and F. J. Chatel, both of the Detroit Edison Co., who outlined the stoker development at this company's Delray Power House No. 3 in the second paper of this session. Improvements were made with two things in mind, namely an increase in efficiency of combustion and the reduction of maintenance by decreasing burned stoker parts. All improvements possible, particularly those to improve combustion, have not been completed but changes which have been incorporated have been thoroughly approved by performance. Automatic control of preheated air in various parts of the fuel bed has been sufficiently developed to establish it as a desirable and valuable aid to combustion, particularly with long stokers burning high-volatile coal. One of the stokers has been operated successfully for a short period with preheated air temperature as high as 500 deg. F. A similar air control system, manually operated, in another of the company's plants has resulted in increased steam capacity of 31 per cent and an increase in calculated boiler efficiency from ½ to 2 per cent.

Central Station Power

Thursday morning three papers were grouped together under the general title Central Station Power although these three papers were applicable to all types of plants and bore little relation to the title of the session.

Stresses in boiler tubes subjected to high rates of heat absorption were pointed out by Wm. L. De Baufre, University of Nebraska. This was the result of an investigation to obtain more accurate experimental data for determining theoretically correct relations for stresses in thick tubes. After calculating the stresses by relations derived for a constant ratio of stress to strain, the results were corrected for plastic flow in the tube walls where the stresses exceeded the elastic limit of mild steel and also for creep which occurs when mild steel is stressed for long times at elevated temperatures. Stresses were investigated for nonuniform heat absorption around the tube circumference as well as for a uniform rate of heat absorption.

In a paper more in the nature of a test code, Sanford A. Moss and Wistar W. Johnson, both of the General Electric Co., outlined the details of a system for the measurement of steam with flow nozzles for turbine performance test. This system is applicable to performance tests of jet condensing, non-condensing or extraction turbines where condensate measurements are out of question. All data and recommendations are on a laboratory basis in order to insure the accuracy necessary where steam turbine guarantees are involved.

Perhaps the most interesting paper of the meeting was the report of C. F. Hirshfeld and G. U. Moran of the Detroit Edison Co. on the performance of modern steam generating units. The authors were requested by the central stations committee of the Power Division to make this investigation and try and provide a yardstick of normal values by which boiler operators might determine whether performance was good, bad or normal. The first year's records were presented in 1920 and showed that the record must be continued longer if significant results were to be obtained. The present paper is an investigation of 250 units in 61 stations and covers a three-year period. Progress report was made at the annual meeting in 1931 but lack of time made it necessary to delay the detailed report until this year. The primary object was to study boiler outages, their cause, and effect of such factors as severity of use, design, fuels and methods of firing on boiler reliability.

Apparently steam generating units are still in a stage of transition from which it is extremely difficult to draw normal operation and maintenance conclusions. Even in this transitory stage, however, modern steam generating equipment may be relied on for use from 82 to 86 per cent of the time. This state of affairs will probably improve in the future but until changes in design become less radical and operating methods are more standardized, normal operation standards cannot be established.

In addition to the above papers relating directly to the power field, there were three sessions the early part of the week under the general title of Working Stress Symposium under the auspices of the Applied Mechanics Division. Among other things the application of creep tests, factors affecting the working stress for high temperature service, test procedure and analysis of test data and similar topics were discussed primarily from the standpoint of the designing engineer. Although there is considerable controversy regarding the test details and stresses to be used, the designing engineer and metallurgist are getting closer together each year and these research investigations are being applied to practical enginereing design.

Federal Power Securities Control

By A. P. Connor*

Recent ruling by the Federal Power Commission is understood to assume control over securities offered to the public by holding companies that have any connection with companies having licenses to use water power under the commission's authority. This ruling provides that before such securities are put on the market or otherwise used in a fiscal transaction, especially where their period of maturity is over one year, they must be submitted to the commission for investigation and approved. Investigation will cover the collateral or real property offered in support of the securities and the commission will pass on the matter by permitting or objecting to the use of that collateral. This move seems drastic in nature and it is evident that it may have far-reaching consequences, particularly if broadly applied.

*Washington Correspondent.

For the 20,000-kw. mercury turbine at Kearney station, General Electric Co. is providing 270,000 lb. of mercury, shipped in flasks of 76 lb. each, the total value being $178,000. This with a like amount to be used at Schenectady represents some 89 per cent of a year's consumption in the United States.

Varied Exhibits at Tenth New York Power Show

GOOD WEATHER AND 300 ATTRACTIVE EXHIBITS
SWELL ATTENDANCE OVER 1930 FIGURES

FOR THE FIRST TIME in 2 yr. manufacturers gathered together to display their new products at what is popularly known as the New York Power Show but formally called the Tenth National Exhibition of Power and Mechanical Engineering. Formerly the show was held annually, but three years ago it was decided to change to a biannual basis, alternating with the Chicago Show, which is usually held in the spring. This arrangement gives a show in every calendar year, at the same time giving a period of practically two years between the preparation of exhibits.

The show was held December 5 to 10, 1932, in the Grand Central Palace, New York City, and probably at no past show was there exhibited such a variety and quantity of absolutely new equipment. Practically every company had two or three feature products on display and not a few had their complete line of equipment entirely redesigned on lines bearing no resemblance to the old equipment. It is quite evident that practically all companies have been using the past year and a half or two years of comparative business inactivity to strengthen their lines so as to be able to take what business there is from competitors.

The variety of equipment was amazing and in contrast to past shows there was very little heavy equipment shown except by models or drawings. For instance there was but one stoker, one pulverizer, one turbine and one engine unit on display. The only trend in development that could possibly be detected was in the line of small reducing gear units in which every manufacturer of gears or motors featured new designs of motorized units with the gear and motor built together. Outside of this the show can not be summarized.

More important than new equipment from a business standpoint the show emphasizes the faith of equipment manufacturers in American business and the fundamental importance of the power industry. As might be expected power plant equipment predominated and a rather significant feature was the increased interest being displayed by manufacturers in the small power plant and equipment user. Heretofore large central station equipment was usually featured, probably because of its more impressive size and performance. In this show most of the exhibits and displays were aimed directly at the small plant and the central station as a unit or industry was practically eliminated.

Power Plant Equipment

The distinction of having the only operating piece of heavy machinery went to the Detroit Stoker Co., who demonstrated a full size working model of the new multiple retort stoker. This machine has square rams with renewable liners, individual shearing pins for each ram, single hand adjustment on the rams and pusher bars, an over-fire sectionalized front wall wind box, grate sections with air control and damper air connection to the power operated dumping grates.

High efficiency small turbines were shown by the Moore Steam Turbine Co. who exhibited the rotor of one of 66 turbines built for the Navy. These are 6000 r.p.m. machines geared to 1200 r.p.m. generators and occupy the same space required by 250-kw. units which they replace. Tests on 250 lb. saturated steam and 28 in. vacuum showed a water rate of 15.3 lb. per kw-hr.

Many interesting features were found in the booth of the Babcock & Wilcox Co. One of these was a mercury vapor generating tube of the type used in the modern mercury boiler, another was a new wide range steam atomizing oil burner for handling acid sludge, and a third a small sized table mill for capacities as low as 400 lb. of coal per hour. In the boiler field they showed a section of a new spun boiler drum with the ends drawn out so that there was no circumferential seam. On large drawings they also showed an arrangement of diphenyl and dowtherm boilers and heat transfer equipment. Another new development was the application of a light weight boiler wall panel made up in sectional wall form with B&W No. 80 insulating brick. This wall was designed primarily as a boiler side wall for use above the furnace. An interesting demonstration using porous No. 80 brick was arranged in connection with a gas furnace. One of the bricks was about 5 in. long, removable and with the inner face so hot that it glowed a bright red the other end was so cool that it could be grasped in the hand.

Foster Wheeler Corp. had on exhibition a new line of axial flow pumps. These pumps, designed for condenser circulating water service, can be installed vertically or horizontally, are built in all sizes and have the space advantages of propeller pumps with very desirable head capacity characteristics. Another development featured was the tricone ball mill arranged for unit system of pulverized fuel firing. The operation of this mill is controlled by a simple controller which actuates a feeder and maintains a constant charge level in the mill. The operation of this feeder was demonstrated by a working model in the booth.

Four sections of boiler tubes were arranged by the Dampney Co. to show the application and effectiveness of Apexior. One tube showed the original mill scale; the second had been sand-blasted; the third had been sand-blasted and coated with Apexior; while the fourth had been sand-blasted, painted with Apexior, and had been in service a considerable period. It had then been cleaned with wire brushes and did not differ from the newly coated tube in appearance. A section of the last tube had been left just as it came from the boiler so as to show the difference between the scaled and cleaned portions and to demonstrate the ability of Apexior to protect the metal.

Clear sight illuminators consisting of a Neon tube arrangement, and adaptable to any round or flat glass, were demonstrated by the Wright-Austin Co. These can be supplied with red or blue lights for any length gage

glass. Another development was the air cooler and separator built in two-inch size and smaller, for air compressor service in lines where dry air is needed for process. They may be used in conjunction with the Whirlwind air separator for the removal of excessive moisture.

Many important and interesting developments were exhibited by the Yarnall-Waring Co. These included the Gunpakt expansion joint so arranged as to show how the joint can be packed under pressure by means of special packing screws, and directly comparing the Gunpakt and Glandpakt Type. Another important development was the application of quadruplex and twinplex bypass blowoff arrangements to take care of continuous or intermittent blowdown. These consist of the regular tandem blowoff valves around which is a small bypass line with one or two small blowoff valves to serve the continuous blowdown equipment. Another development was an operating installation of the Eye-line water level indicator which can be furnished with or without a remote electrically operated water level recorder.

In addition to a section of air heater, the Air Preheater Co. made a feature of the Ljungstrom double rotation steam turbine which is now built for units up to 50,000 kw. and with designs available for capacities of 160,000 kw. This company now represents the Ljungstrom steam turbine in this country. This type turbine which is now well known was first built in 1908. It is of the radial flow double rotation type with two independent sets of concentric blade rings which operate in opposite directions and ordinarily does not make use of stationary blading.

Another exhibit which created an unusual amount of interest was the vacuum vapor power plant of the Cochrane Corp. Vapor from a drum of water impinged upon a small turbine wheel, the vapor then passing to an atmospheric condenser kept cooled by a wick saturated with water. Another item of interest was the pilot actuated water regulating valve. In this valve both the main and pilot valves are single seated and close with the pressure. The pilot is actuated by the float and the main valve, actuated by a hydraulic piston follows up and moves with the pilot to avoid hunting; the pressure, of the liquid being controlled, is used to operate the valve so that no auxiliary fluid is required. This valve is also used as an overflow valve in connection with deaerating heaters and for that service is arranged to be operated by a float under a moderate head of water.

Fully automatic control for Zeolite water softeners was shown by moving exhibits and cutaway models by the Permutit Co. The operation is controlled by a water meter, time switch and flow switch, the automatic operation being made possible by the development of a motorized single valve control. This equipment is adaptable to the present softeners and can be applied to any existing downflow Zeolite water softener. At another booth the same company demonstrated the use of a continuous blowdown and had on hand a new heat exchanger to show changes and improvements recently made.

Nalco No. 8 was the new product featured by the National Aluminate Corp. This is an anti-incrustant or scale retarder for use in feed lines, heaters, pumps, oil engines, condensers and heat exchangers. It is sold in ball form and can be used independently or in conjunction with lime and soda-treated water. Prevention of scale by this means is known as delayed reaction with the treatment adjusted, so that the scale forming materials do not precipitate out while in use.

Rerefining tests of twelve brands of oil and the

results obtained in these tests were shown by the Tidewater Oil Sales Corp. in a striking exhibit. Twelve competitive oils were bought in the open market and refined in the Tidewater laboratory, in order to determine the impurities left in the oils by the conventional refining methods and to determine the effect of these processes upon the oils themselves. The laboratory results of the tests were shown in the exhibit plotted on a large board with rectangular coördinates. Extracts of sludge forming substances varied from about 10 to 25 per cent.

In a very complete exhibit of the oils and greases made by The Texas Co., a new gear demonstration unit was featured. This unit, operated in a glass case, was arranged to show the adhesive qualities of Crater compound which does not thin and drip off the gears even under the temperatures maintained in the can.

In their first exhibit since merging the Standard Oil Co. of New York and the Vacuum Oil Co. held a joint exhibit of Socony-Vacuum products.

Valves

Welded end valves for 600 lb. pressure were exhibited by the Lunkenheimer Co. These valves made to be welded in the line have the same face to face dimensions as flanged valves. The first complete installation will be the Bogalusa Paper Co. in Louisiana and valves for this plant were exhibited in addition to a complete line of the companies regular flanged and screwed carbon steel and alloy steel valves. The new welded end valves the first to be announced created an unusual amount of interest and it has been predicted will become standard valve practice in the near future.

Among the many valves exhibited by Jenkins Bros. a new re-grinding valve known as type 890 was featured. This is an iron body bronze trimmed valve with a re-grinding union bonnet and renewable seat ring built for 150 lb. steam pressure or 250 lb. oil, water and gas working pressure. The bonnet is made with an exceptionally deep packing chamber and a heavy cast-iron bronze union ring gives the valve strength for long performance in severe service. This type is made in the globe, angle and check types. Nickel alloy seat and disc are regularly supplied but bronze or stainless steel can be furnished if desired.

Forged steel valves of all types and sizes in stainless and carbon steel were shown by the Henry Vogt Machine Co. These valves which can be made from any metal that can be forged, formed an interesting exhibit, particularly on the table showing the fittings in various stages of manufacture from the billet through to the finished product. Forged steel return bends, 6-in. screwed ells and tees and carbon steel bodies with stainless steel liners made for refinery service were some of the unusual items in the exhibit.

Piping and Metallurgy

Two new products were exhibited by the National Tube Co., the first a new line of stainless, seamless, steel tubing of unusual ductility and easily worked. It is available in round, square and rectangular shapes and offers a combination of effective corrosion resistance, improved strength and high temperatures and clean, bright surfaces. The different alloys range from 11 to 30 per cent chromium. The second product was cement lined pipe with a high resistance to corrosion and to temperature changes since the thermal expansion properties of the cement and steel are practically equal. It is made in sizes of from 12 to 30 in. and can be furnished either bare, galvanized or with other outside coatings suitable for the service involved.

Many advances in metallurgy were shown by the International Nickel Co., Inc. These included applications of cast iron with small parts of nickel, advances in the hardening and resistance of cast monel, and the production of K monel metal which can be rolled and heat treated and has a tensile strength of 95,000 lb. per sq. in. Another metal was an 85 per cent nickel, 12 per cent chromium alloy, developed primarily for the dairy trade because of its resistance to lactic acid. It is also highly resistant to oxidation and is finding many other industrial applications. Many applications of the various metals were shown, one in particular being an alloy cast-iron cylinder liner for Diesel engines.

Directed flexing of the compensating member of the new Badger corrugated expansion joint was shown and demonstrated at the booth of E. B. Badger & Sons Co. In this new joint the corrugations flow back and forth over a curved surface of the equalizing ring which distributes the stresses uniformly throughout the entire corrugation resulting in longer joint life due to the prevention of localized flexing stresses.

Pipe Tools

The Nos. 1-2-4, one to four-in. power pipe machines, a fast high speed production unit, was the main feature of the Toledo Pipe Threading Machine Co. booth. The motor was on the rear of the machine and a large tool tray in the base provides room for die heads and other tools. The six spindle speeds are obtained with one clutch lever and gear shifting lever controlled by the operator's right hand. The company's line of smaller tools was also exhibited and the Toledo Super-threader was made a special feature among these. This is a new three-jaw pipe holder with the three broad-faced chuck jaws holding the die rigidly to the pipe, assuring a clean, perfectly tapered thread.

A noiseless and shock-proof boiler feed return trap was demonstrated at the exhibit of the Bundy Steam

Trap Co. This new trap which is made sound proof by the addition of a primary steam valve which opens about three seconds before the main steam valve so that the steam pressure is built up slowly without shock. The trap is designed to eliminate water hammer which causes leaky pipe joints and ruins check valves. Another important item of the exhibit was the Bundy Junior, a new small inverted bucket trap, having large capacities and the valve and disc easily removable as in all Bundy traps.

To increase the air handling capacity of traps the Armstrong Machine Works introduced and were featuring at the Show the Armstrong Thermic Unit. This consists of an auxiliary air vent closed by means of a flat bimetal strip installed at the top of the trap bucket. With the trap cold the strip holds the valve disc away from the vent. As the temperature rises the auxiliary valve is closed and the trap bucket functions in a normal manner.

Insulation and Refractories

Alumino Hi-Temp was one of the principal items exhibited by the Philip Carey Co. This material which is good for temperatures up to 2000 deg. F., is made primarily for use between fire bricks or as a lining in high temperature ducts if faced with some material to prevent abrasion. A demonstration showing its effectiveness as an insulating material was made in connection with a 1400 deg. gas fired furnace with Alumino Hi-Temp on one side showing a face temperature of 130 deg. F. as compared with 227 deg. for the diatomaceous brick used on the other side. This material is ordinarily supplied in blocks 9 by 36 in., 2½ in. thick, but can be supplied in other shapes and thicknesses for special purposes.

In order to show the difference in heat conductivity of various bricks Carborundum Co. installed in their booth an electrically heated furnace one side of which was made up of four different bricks, Carbofrax (silicon carbide), Alfrax (aluminum oxide), fire clay and Infrax (insulating brick). The temperatures of the outside face of the four bricks varied from about 950 deg. for the Infrax to 1500 deg. for the Carbofrax, the other two being somewhere in between. Temperatures of the outside surface could be read by means of a five-point pyrometer.

To demonstrate the difference between heat losses from bare and insulated pipe, Johns-Manville Corp. performed an interesting experiment on two sections of heated pipe. One section was well insulated, the other section was not. Relative heat losses by radiation were indicated by the temperature of metal plugs located in the observation window. The plug opposite the covered section was comparatively cool to the touch while the plug opposite the heated section was hot enough to burn the fingers. Another comparatively recent development feature was transite pipe.

Two items of great importance to power plants were featured by the Brown Instrument Co. The first was the new mechanical flow meter with pressure or temperature compensation, a simple and direct lever actuating mechanism and a pressure type bearing with a series of range tubes that permit changing the range of the meter without disturbing the orifice in the pipe line. It is provided with a simple check valve to prevent the mercury flowing out at the low pressure connection and the high pressure chamber is tested to 2000 lb. The second instrument was a smoke recorder using a photo-electric cell, a special device to keep the lens free of smoke, and a strip chart recorder.

In a cutaway model the recently redesigned Bailey mechanical flow meter was shown by the Bailey Meter Co. The mercury chamber has been changed in shape and the Ledoux bell is now vertically guided by means of a special parallel motion at the top of the chamber, a rubber valve plate seals a low-pressure connection and prevents the loss of mercury on unusual pressure differentials and the integrator is of the intermittent type consisting of an escape wheel and a pawl which is disengaged by a cam under the control of a roller arm operated by the same mechanism that moves the pen arm. Another interesting feature of the exhibit was a large colored sectional drawing showing the steam boiler and the application of the Bailey control equipment to the new General Electric mercury plant.

Republic Flow Meters Co. exhibited in operation their new CO_2 meter in two types, the MDI mechanical,

and the MDE electrical. In addition they had models of recent boiler panels from such well known installations as the Bogalusa Paper Co., City of Hamilton, Ely, Lily & Co., and Kruger Grocery Co. These panels used the multipen strip recorder of the type shown in the exhibit by an eight pen model.

Control Equipment

New drawn steel float cages giving a close grained wall of uniform thickness with a third less weight making them much easier to support and install was the big feature of the Fisher Governor Co. exhibit. These new float cages will be used with liquid level controllers for high pressure, high temperature and severe service conditions. The body and arm of the new unit are normalized open hearth steel, formed and drawn by hot and cold operations to give uniform thickness and grain structure properly reinforced by a unique rib-welding process, cages suitable for a pressure of 750 lb. at 100 deg. F., 610 lb. at 600 deg. F., or 410 lb. at 900 deg. F. They also exhibited a complete new line of motor operated valves built in sizes from ½ to 16 in. with motor drive for low-pressure work as well as a complete line for heavy duty industrial service.

A new electric temperature regulator operating in six definite steps was featured by the Sarco Co. This is a mercury actuated instrument which operates relays

controlling the power input to a small oil heater. Vapor pressure developed by the electric heating element actuates a balanced valve in the steam line. Another development featured was the temperature regulator for brine control in refrigerating service. In this control the expansion of oil in the primary element is used as the pressure transmitting medium to operate a balanced valve.

Power Transmission

In an extensive exhibit of industrial control and lighting equipment which included photo-electric cells, Thrustors, welding equipment and a motor-driven centrifugal blower demonstrating the volume control equipment of the company, the General Electric Co. featured motorized gears in which the gear unit and motor are built as a single unit. These gear units are made in a complete range of sizes and speed reductions applicable to all types of industrial service.

Heating and Ventilating

For process heating requirements the L. J. Wing Mfg. Co. developed and exhibited the Weatherfin unit which will handle air at any intake temperature and deliver it at any temperature within the range of the steam pressure available. It is a compact unit with the driving motor or turbine located outside of the air current. The fan housing may be turned so that the inlet is at the top, bottom or side and any number of elements may be placed in the discharge to obtain sufficient heating surface.

Among an impressive exhibit of large rolling mill roll neck bearings and locomotive bearings the Timken Roller Bearing Co. made a feature of their detachable bit for drilling rock. The Timken rock bit replaces the conventional bit forged on the end of the hollow drill steel. It is held in place by a left hand thread which is opposed to the direction of rotation of the steel so that it is held directly against the shoulder with none of the force of the blow absorbed by the thread.

Miscellaneous

Irving decking, an open steel flooring for bridges and similar application, was the most striking feature in the Irving Iron Works Co. booth. This product is continuous in all directions offering no separate panels or joints and its application was shown by means of a small bridge model.

Griscom-Russell Co. featured the G-Fin tubing intended primarily for oil heater construction and used whenever an extended surface tube is necessary. These tubes have radial fins parallel to the longitudinal axis. The heaters in which they are applied are intended for storage oil tanks and only the portion of the oil being drawn out is heated, the balance of the tank being unheated.

Differential coupling with ends having 4 and 6 pitch threads, thus drawing up 1/12 in. per turn, for installing parallel pipes on close centers was a product of Key Boiler Equipment Co.

In the field of instruments, a direct reading vacuum gage giving readings corrected for barometric variation and compensated for temperature was shown by The Bristol Co. Accuratus small bore tubing with a core wire to make possible use of mercury-actuated thermometers on tube length up to 100 ft., unaffected by temperatures up to 200 deg. around the tubes was demonstrated by Taylor Instrument Co. Six-point potentiometer recorder driven by a synchronous motor and inking in 6 different colors was in the exhibit of the Foxboro Co.

For keeping condensers tight, a tool for packing, ferruling or expanding tubes into the tube sheets was demonstrated by Condenser Service & Eng'g Co., also test method of soundness of tubes before installation and condenser injector for supplying sealing compound to stop condenser tube leaks while in service. Another device was to remove air from water boxes at tube entrance for single-pass or at the end of the second-pass for two-pass condensers.

Automatic priming of centrifugal pumps by a float chamber on the suction where float falling acts to open the chamber to a vacuum pump or to turn pressure onto a water ejector was shown by Skidmore Corp.

Interesting items of furnace practice were a new steel-cased setting with 4 in. of hollow tile to replace 12-in. brick wall by the Plibrico Jointless Fire Brick Co.; a new type superheater for return tubular boilers, temperature controlled by regulating the distance between units and boiler shell, made by the Superheater Co.; a flue gas scrubber in the steam generating unit of Riley Stoker Co., having a thin film of water flowing over vitrified enamel plates against which the gases impinge.

Colorado River in a Hole

By A. P. Connor*

At the site of the Hoover Dam at Boulder City, Nev., an entire river has been turned through a mile-long tunnel to clear the bed for work on the dam. On Sunday, Nov. 13, a blast of dynamite blew out the wall between the river and the tunnel and for 24 hr. steam shovels worked to clear away the debris for deposit in the old river bed, to complete the diversion. This 50-ft. tunnel, which has taken a year to blast through the rock, will carry the whole river clear around the working area for the dam, coffer dams, already started, serving to prevent interference. Excavations to solid rock will carry the foundations 130 ft. below the level of the old river bed, removing some 500,000 cu. yd. The dam, rising 700 ft., will contain 3,500,000 cu. yd. of concrete and will require 3 yr. more to complete.

In addition to the diversion tunnel now opened, three more are to be completed and ready before the spring floods occur. The present one is calculated to take the expected flow of the river in the period up to next spring. These tunnels, which average 3000 ft. long, are dug and blasted out of the rock and lined with concrete.

Excavation for the two large 450-ft. spillways of the dam is nearly completed, one spillway on the Nevada side of the dam, the other on the Arizona side. The dam length on the crest is to be 1180 ft. and its width 45 ft. The pond or reservoir of impounded waters is to have a capacity of over 30,000,000 acre feet, will extend 115 mi. up the Colorado River, 35 mi. up the Virgin River and will be about 8 mi. wide. Its area will be 227 sq. mi. The power capacity to be arranged for and developed will be 1,200,000 hp.

*Washington Correspondent.

New Equipment

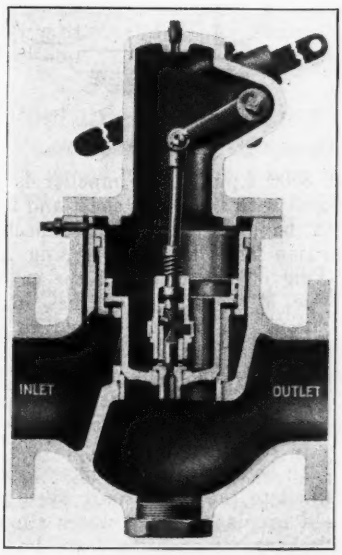
Pilot-Controlled Regulating Valve

IN THIS valve, lately introduced by the Cochrane Corp., Philadelphia, a pilot actuated by a float or other primary control admits the supply pressure to a hydraulic piston, which follows up and moves with the pilot, thus avoiding overtravel and hunting; the pressure of the liquid being controlled is utilized for the operation of the valve.

As shown in the accompanying cross-section, the valve is in closed position. Into the valve body is fitted a combined hydraulic power cylinder and seat ring, the power end of the cylinder being somewhat larger in diameter than the port opening through the seat. V-shaped flow ports are cut in the small-diameter part of the cylinder which connects the power end with the seat. Working within the cylinder is a combined piston and single-seated valve, the upper or piston part of large diameter fitting into the large diameter of the working cylinder, while the valve part extends down past the flow ports and engages with the seat when in the closed position. When this valve and the pilot valve are in the closed position, as shown, pressure equalization takes place between the inlet and the space above the piston, hence the valve is held tightly to its seat by the inlet pressure.

Seating upon a port pierced through the center of the valve disc, the pilot valve is actuated directly by the external lever through a rotary spindle and connecting rod, as shown. When the pilot valve is lifted, the pressure above the valve and piston at once drops to that existing on the outflow side of the valve. The inlet pressure acting upon the annular area enclosed between the circle of the valve seat and the larger circle of the operating cylinder is then unopposed and lifts the main valve, but the latter cannot move suddenly, as the inflow to the annular space is throttled. Rise of the valve will continue until the pilot port again approaches the pilot valve, so that outflow from above the piston and main valve is restricted, the main valve coming to rest in such position that rates of inflow to the space above the piston and of outflow through the pilot are equal.

When the float moves the pilot valve towards the closed position, pressure builds up above the piston and main valve, forcing the latter toward the closed position, the action continuing as far as the pilot follows up, until the main valve is closed. Should there be but slight pressure on the inlet, the float may operate the main valve directly.



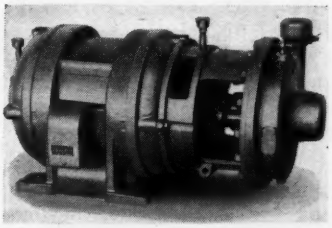
In the larger sizes, the pilot valve stem is fitted with an auxiliary multiplying lever as shown, by which means the pull upon the pilot valve stem, to start the pilot valve from its seat, is multiplied by three for a short part of the stroke, after which the main valve follows up the full motion of the valve stem. Thus a small float or small float movement can be used to give the needed pilot-opening effort and the same main valve movement.

To protect the auxiliary multiplying lever and its bearings from excessive force due to the action of the float in either direction, when the float has risen to the upper extreme of its motion, the bell crank strikes a lug in the top of the valve cover. On the downward stroke, pressure upon the auxiliary lever is transmitted through a spring, which, when the pilot valve has reached its seat, compresses until the main stem comes into direct contact with the pilot valve, thus preventing further increase of pressure upon the small lever.

As bodies of the larger valves are ordinarily made of either cast iron or cast steel, depending upon the pressure, while the operating cylinder and valve seat are of brass or bronze, to allow for the difference in expansion of the two metals, the joint between the cylinder and the valve casing is sealed by a split ring. To provide adjustment of the relative rates of opening and closing, the flow of liquid from the inlet side of the main valve to the space above the piston is taken partly through a passage bored through the wall of the casing and throttled by an adjustable control plug. Screwing this plug in causes the main valve to open rapidly and close slowly, and vice-versa.

Motor-Driven Pump

ALLIS-CHALMERS MFG. CO. has extended its line of SSU motor-driven, single-shaft, two-bearing pumping units by three sizes to work against heads up to 100 lb. (231 ft. head) and above and covering a range in capacity from 30 to 140 g.p.m. Pumps and motors

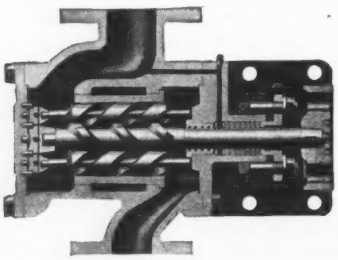


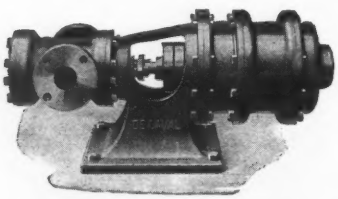
are proportioned to work together, a single shaft being used on which to mount the motor rotor and pump impeller, supported by two ample ball bearings. This construction does away with any possibility of misalignment between the pump and the motor.

SEIZO_2 is the name given by The Hays Corp., Michigan City, Ind., to an oxygen absorber to be used in gas analyzers in place of pyrogallic acid. It is claimed that two passes through the absorption chamber filled with steel wool and SeizO$_2$ will remove all trace of oxygen from the gas and that the effectiveness is maintained for at least 300 analyses.

Rotary Displacement Pump

In this new type of rotary displacement pump, power is supplied to a central rotor, which meshes with one or more sealing rotors of such form that they are propelled largely by fluid pressure, with a minimum of mechanical contact, threads of the power rotor being convex, while those of the idler rotor are concave. This patented tooth form accomplishes sealing so effectively that but few turns of the thread around the rotor are required to keep slippage to a small value. Efficiencies of 80 to 90 per cent are reported on independent, impartial tests. Velocity of the liquid through the pump is low with no trapping or cutting off of liquid in tooth pockets, the pump operating successfully and quietly at high motor speeds and even at turbine speeds.





Only three moving parts and, except for small thrust buttons to maintain the relative axial positions of the rotors, no separate bearings are used, only one stuffing box being necessary. These pumps have been developed by the De Laval Steam Turbine Co., Trenton, N. J., and are known as De Laval-IMO pumps. They are available regularly in capacities ranging from ½ to 700 g.p.m. and for pressures up to 500 lb. per sq. in., but pumps for higher pressures and capacities can be supplied.

Pumping Unit

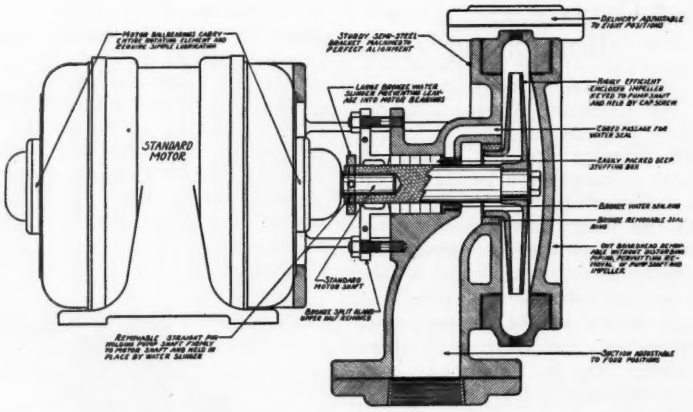
American Steam Pump Co., Battle Creek, Mich., has designed a single-stage centrifugal pump assembled with a driving motor, for capacities from 5 to 450 g.p.m., at heads of 5 to 120 ft. These use standard motors with the pump overhung from the end of the motor frame, reducing floor space and foundation requirements. Two types are made: MUE with end suction to the pump casing, motors 1/16 to 1½ hp. at 1750 r.p.m. and ¼ to 5 hp. at 3500 r.p.m. The impeller is integral with the pump shaft and both can be removed by disconnecting suction and discharge piping and taking off the volute of the casing. Type MUI, illustrated, has inside suction, the impeller keyed to the pump shaft and both can be removed without disconnecting the piping by taking off the outboard head. This type uses motors from ¾ to 10 hp. at 1750 r.p.m.

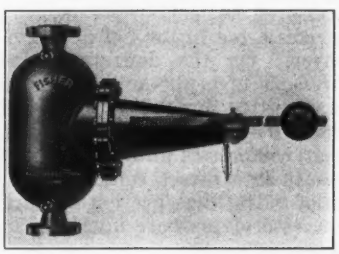
In both types, the pump shaft is joined to the main shaft by a pin, held in place by the water slinger. Discharge connection can be revolved to any of 8 positions; suction on the MUI type is adjustable to 4 positions. Units can be operated in vertical or inclined positions as well as horizontal.

Liquid Level Controller Float Cage

Fisher Governor Co., Marshalltown, Ia., has just announced the introduction of its drawn steel float cage for use where a float outside a tank or tower is required to operate a lever valve, pilot valve, indicating device or switch mechanism.

Following original pioneer work in float cage controllers for pressures of 125, 250 and 600 lb., the Drawn Steel cage continues the original Fisher feature of a bolted flange of high-pressure boiler plate between the cage body and arm, so that the float can be removed or inspected without removing the cage from position. Developed by 18 mo. of experiment, research and design, the new cage is made of open hearth flange steel of 65,000 lb. per sq. in. tensile strength, suitable for 610 lb. pressure and 600 deg. F. or 410 lb. and 900 deg. It is formed by hot and cold forging, the nipple on the cage body and flanges at top and bottom being welded on by an unique process so as to be integral with the body as a unit. Use of drop forged steel flanges and uniform wall thickness gives greater strength with 60 per cent less weight than former cast steel construction.



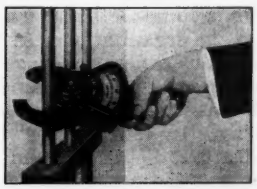


Fittings include ball-bearings, grease-seal stuffing box and stainless steel ball float.

Reduction in size for a given rating and lower price are advantages of a new General Electric Co. line of Pyranol-filled capacitors for power-factor correction. Units consist of one or more flattened rolls, each having two sheets of aluminum foil separated by thin laminations of paper, pressed together, connected in one, two or three groups for 1, 2 or 3-phase units, enclosed under Pyranol in a hermetically-sealed steel case and leads brought out through porcelain bushings. The box type for indoor service can be connected directly to motor terminals or the line side of motor switches. Rack type for indoor or outdoor use may be combined to cover a wide range of desired kv-a. ratings, permitting corrective capacity to be installed in small or large blocks at the most advantageous points to reduce line loss.

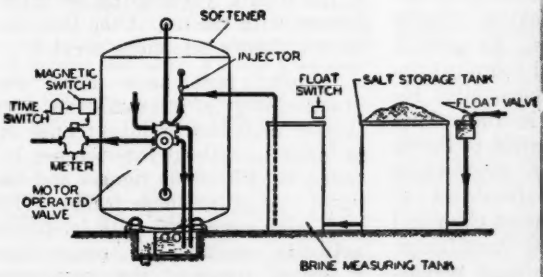
Current Measurement Without Cutting Into Circuit

OFTEN it is desirable to measure current in cables or other conductors without interrupting the circuit long enough to connect an instrument into the line. The Tong-Test meter shown herewith, developed by Columbia Electric Mfg. Co., Cleveland, Ohio, permits such measurement to be made of either direct or alternating currents without shunts or transformers. It is of split electromagnet type, without electrical windings, magnetic flux around the conductor operating the meter, and can be attached with one hand. The laminated magnet yoke is made in two parts, which are separated by a pressure trigger so as to pass them around the conductor whose current is to be measured. The trigger is then released and the reading taken. Jaw opening will take cables up to 1⅝ in. diam. Readings can be taken for direct current on single cored cables of armored type or even if run in steel conduit. Interchangeable elements permit change of measurement range, 50, 100, 150, 200 and 400 amp. capacity being standard sizes.



Automatic Water Softener

THIS FULLY AUTOMATIC industrial zeolite water softener just announced by The Permutit Co., 440 Fourth Avenue, New York, is designed to eliminate errors due to the human element and to conduct all the operations of softening and regeneration with machine-like regularity and precision.

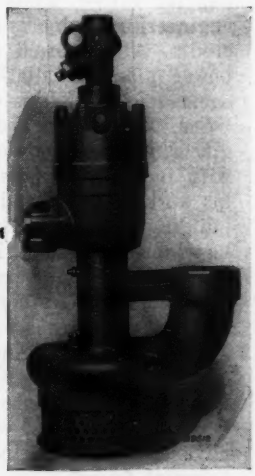


Briefly, at the end of the softening run, the meter actuates the electrical controls, which carry through the steps of: Cutting the softener out of operation; backwashing it for a regulated period to secure thorough cleansing; admitting such amount of saturated salt brine as to assure thorough regeneration without wastage; rinsing out the hardness salts to waste with minimum amount of water; throwing the softener back into service thus placing it again under control of the meter, which by a switch and electric controls governs the volume of water to be softened during the softening run and initiates the start of the next regenerating cycle.

It is a relatively simple matter to apply the automatic control to existent downflow softeners thus converting manual to fully automatic operation.

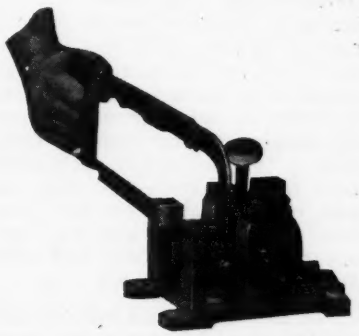
Portable Sump Pump

NEW PORTABLE, air-operated sump pump for use by mines, refineries, public utility companies has been developed by Ingersoll-Rand Co., 11 Broadway, New York, with an open-impeller type centrifugal pump driven by a multi-vane type air motor, both enclosed in a one-piece housing. Typical uses are pumping from sumps, trenches, manholes, cofferdams. The pump will handle clear or dirty water, oil, sewage, or moderately heavy sludge. It is intended for lifts of 10 to 40 ft. with air pressure of 70 to 90 lb., but will give satisfactory results under widely varying conditions of head and air pressure. Using air at 80 lb. pressure, the capacity ranges from 170 g.p.m. with 10-ft. lift through 20 ft. of 2½-in. hose to 125 g.p.m. with 40-ft. lift through 50 ft. of 2½-in. hose. The pump has no suction lift and must be submerged to cover the inlet strainer.



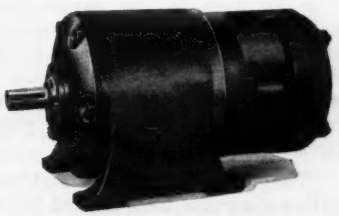
Sawing Vise

FOR CUTTING square ends on thin-wall tubing a vise has been developed by the Borden Co., Warren, Ohio. It is made of aluminum with steel inserts, will handle tubing from ⅛ to 2 in. diam. without crushing it and insures accurate centering by use of a long V trough. Square ends are thus insured for compression or soldered joints.



Motor Reduction Unit

ALLIS-CHALMERS MANUFACTURING CO. announces the development of a motor reduction unit for use where low speed drives are required, having a standard round frame type motor mounted directly on the helical gear reducer housing, thus forming a compact unit. Standard speeds at the power take-off are from 3.92 to 380 r.p.m. but lower speeds can be provided. 6.08 r.p.m. is obtained with the use of a 1750-r.p.m. motor.



Bearings supporting the gear drives are ball or roller type, with automatic lubrication. Standard units are arranged for floor mounting but units can be supplied for wall, ceiling or vertical mounting, with any desired type of motor, standard squirrel cage, wound rotor, enclosed fan-cooled, explosion proof, or direct current. Inherent advantages of separate motor and reducer construction are ease of maintenance, replacement of individual units, adaptability to change in ratios.

N.A.P.R.E. Convention Chicago, Ill.

UNDER the general supervision of Mr. and Mrs. George Reichel the 23rd annual convention of the National Association of Practical Refrigerating Engineers at the Sherman Hotel, Chicago, was a marked success. This was the second time the National convention was held in Chicago, the first being in 1920. In the intervening 12 yr. the association grew from 150 members in two chapters to 3000 members in 50 chapters. During the past year a total of 395 new members were enrolled and two new chapters, Phoenix, Ariz., and Terre Haute, Ind., were added.

In accordance with past practice the Question Box was a feature of each technical session, one period being conducted by each of the following: H. G. Venemann, Lafayette, Ind.; C. T. Baker, Atlanta, Ga.; H. T. Holbrook, San Francisco, Cal.; and K. M. Holaday, Springfield, Ill. Technical papers covered a wide field, including condenser failures by H. C. Guild, A. M. Byers Co., Solid Carbon Dioxide by F. R. Zumbro, Frick Co., Dairy Refrigeration by H. S. Fielder, Cherry-Burrell Corp., Plant Operation by W. E. Zieber, York Ice Machinery Corp., Booster Compressors by Harry Sloan, Vilter Mfg. Co., Common Sense by R. H. Smith, Westerlin & Campbell Co., Comfort Cooling by M. G. Harbula, consulting engineer, Unit Coolers by George B. Bright, consulting engineer, Refrigerating Machinery Motors by R. C. Allen, Westinghouse Elec. & Mfg. Co.

In addition to the papers there was a demonstration of research magic by R. H. Maxwell of the Westinghouse Elec. & Mfg. Co. in which he demonstrated some of the remarkable properties of the photo-electric cell.

The following officers and committee chairmen were elected for the coming year:

President, John W. Neff, La Grange, Ill.; 1st Vice-President, Martin Vander Veer, New Haven, Conn.; 2nd Vice-President, George G. Wall, Omaha, Nebr.; Secretary, Edward H. Fox, Chicago, Ill.; Treasurer, Louis P. Mantz, Pittsburgh, Pa.; Sergeant-at-Arms, Charles A. Conley, Memphis, Tenn.; Chairman Board of Directors, J. E. Petermann, Hubbard Woods, Ill.; Chairman Board of Advisers, James S. Spalding, Memphis, Tenn.; Chairman Educational and Examining Board, Edwin S. Libby, Chicago, Ill.; H. C. Guild was elected as a new member of this Board primarily to take care of the eastern district; Chairman Membership Committee, Roy H. Smith, Chicago, Ill.; Chairman Committee on Standards, W. J. Lewis, Jr., Rochester, N. Y.; Chairman Committee on Engine Room Records, Emerson A. Brandt, Chicago, Ill.; Chairman Committee on Exhibits, A. P. Dougherty, Niles, Ohio.

Hubert E. Collins

Mr. Collins, for many years a well-known member of engineering and Masonic organizations, died at his home in Utica, N. Y., Oct. 31, 1932. He was born in Boonesboro, Ia., March 27, 1872. Taking part in the development of the West, he has recorded some of his early experiences in a vivid story of those days, Warpath and Cattle Trail,

which showed his versatility as a popular author, while ten books on engineering subjects are to his credit. After varied experience in power plant installation and management, Mr. Collins established at Utica, 18 yr. ago, a consulting engineering practice, dealing largely with industrial plants. As part of his work he wrote and compiled the building code for his home city. He has been prominent in the affairs of the National Association of Power Engineers and other engineering societies, serving as president of Mohawk Valley Engineers Club and of the New York State Association, N.A.P.E. He will be long remembered as an earnest worker for the advancement of engineering and as a genial friend.

Seabury S. Gould

SEABURY SMITH GOULD, vice president of Goulds Pumps, Inc., died on November 25, at the age of 44.

Mr. Gould, after graduating from Hamilton College with the class of 1911, entered the sales department of The Goulds Manufacturing Co. to gain first-hand knowledge of selling methods and problems of the organization. After two years of this experience he returned to the main office staff, and later became assistant treasurer of the company. In 1917 he was commissioned a first lieutenant and served throughout the period of the World War. He has been a director of the Gould corporation, a vice-president for several years, and for the past year, has served as secretary.

Mr. Gould was a Mason in Pocahontas Lodge, No. 211, F. & A. M., of Salem Town Chapter, No. 173, R. A. M., and a member of the Seneca Falls Rotary Club, serving as its president 6 yr. ago. He became a director of the Utica Mutual Insurance Co. early this year. Mr. Gould devised the farm plot plan for employes of the company early this year by which acres of land owned by the company were used to produce foodstuffs for families of Gould men.

Long Distance Metering

PERFORMANCE of the Chronoflo meter for long distance registering and recording of levels, pressures, positions of gates and valves, and rates of flow was demonstrated at Springfield, Mass., by Builders Iron Foundry of Providence, R. I., over lines of the N. E. Tel. & Tel. Co. from Provin Mountain, 5 mi. away, and from Harriman hydro-electric station, 42 mi. distant. From these plants, electrically-operated chart recorders were "plugged in" on standard telephone circuits and impulses operated the meters at Springfield, duplicating the records at the plants, yet causing no interference with the use of the lines for their ordinary telephone service.

Similar tests have shown the practicability of transmission over shorter distances or longer ones up to 500 mi., without interference between the Chronoflo signals and the usual load of telephone traffic. With such wide range and with telephone networks available for transmission it seems apparent that numerous uses for the method and equipment will develop in utility systems, pipe lines and large industrial plants.

News From the Field

PRIZES to be awarded by the N.E.L.A. at its 1933 convention are as follows: Gold medal donated by Henry L. Doherty for the most meritorious paper on any subject dealing with electric light and power; cash prizes of $250, $150 and $100 donated by Byllesby Engineering and Management Corp. in memory of Col. H. M. Byllesby for the three best papers on increasing usefulness of the accountant in public utilities; cash prizes of $250, $150 and $100 donated by James E. Davidson for three best papers on commercial or merchandising problems of the industry; cash award of $250 donated by B. C. Forbes for best paper dealing with public relations; cash prizes of $150, $100 and $50 donated by A. L. Lindemann for three best papers on electric cookery for households; cash prizes of $250, $150 and $100 for three best papers on any engineering or technical subject relating to the industry; certificate donated by Kenneth Curtis in memory of Augustus D. Curtis to the company making the greatest contribution to the advancement of lighting of buildings and prize of $250 to the person responsible; gold medal donated by James M. Gilchrist for company showing the greatest contribution to the advancement of electrical advertising and prize of $250 to the individual responsible, also honorable mention and prizes of $150 and $100 for second and third places; bronze plaque donated by Thomas W. Martin to company making greatest contribution to rural electrification. Any person employed by a member company is eligible but no person can win a prize 2 yr. in succession, and no paper can be submitted in more than one contest. The first page must show: Name of prize contest, title of paper, author, employing company, title or position of author, home address. Merit of papers rather than elaborate presentation will govern. Papers and exhibits must be forwarded by Mar. 1, 1933 to the Secretary, N.E.L.A., 420 Lexington Ave., New York City. Registration blanks for company awards can be had from Commercial Department, N.E.L.A. at the above address.

A. M. SNODGRASS, formerly superintendent of the meter department at Fort Wayne, Ind., and production manager of the West Lynn, Mass. works, has been appointed production manager of the Pittsfield, Mass., works of the General Electric Co.

CARL STRIPE, formerly with Westinghouse Electric & Mfg. Co. at Pittsburgh and later with Combustion Engineering Corp. of New York has changed his field of activity and taken a position as assistant to the vice-president of Davis Coal and Coke Co. to head its engineering organization in the New York office.

WILLIAM J. O'MEARA has been appointed engineer of the Baltimore office of the General Electric Co. Entering the company's test course in 1919, he became a student engineer in 1923, later going to Philadelphia as construction foreman on outside construction work. In 1930 he was made office engineer in the engineering department at Philadelphia and, during the past year, was again assigned to outside construction work there.

GEORGE P. BALDWIN, vice president of the General Electric Co., in charge of activities connected with steam railroad electrification and other duties assigned by President Gerard Swope, died of pneumonia Dec. 7 after an illness of only a few days. Mr. Baldwin was born in San Francisco in 1874 and was graduated from Leland Stanford University in 1896 with the degree of A.B. In the following year he entered the employ of the Stanley Electric Co., bought in 1903 by the General Electric Co. At that time Mr. Baldwin became vice-president of the Blaisdell Co. of Los Angeles, where he remained until he was made manager of the Pittsburgh office of the General Electric Co. in 1910. In 1915 he became manager of the Atlantic district of the company, with headquarters in Philadelphia; in 1923 he was made manager of the new Merchandise Department and in 1925 became vice-president of the company, with headquarters in New York City.

AT THE 28TH ANNUAL MEETING of the A.S.R.E. held at the Hotel New Yorker, New York City, Dec. 7, 8 and 9, 1932, a well balanced program covering all phases of the refrigerating industry was presented. Sessions included air conditioning, thermal problems, research, refrigerating plants and the commercial domestic field. Inspection trips on the last day included the National Broadcasting Studios and the Reid Ice Cream Plant. New officers elected were: A. W. Oakley, Merchants Refrigerating Co., New York, president; Harry Harrison, Brunswick Div. of Carrier Corp., New Brunswick, N. J., vice-president for 2 yr.; George Lange, American Ice Co., New York, N. Y., treasurer; David L. Fiske, New York City, secretary.

NEW YORK OFFICE of Roots-Connersville-Wilbraham is now located at 24 State St., with D. L. Dowling as district manager, N. C. Barnard and A. E. Loyd as sales engineers.

FRICK CO., Waynesboro, Pa., announces that W. H. Aubrey is now sales manager of the Ice and Refrigerating Machinery department, succeeding A. H. Baer, who will go with Carbondale Machine Co.

AMERIKA-INTERESSEN, Inc., Chrysler Bldg., New York City, has been organized to arrange for the use of patents, on royalty or sale basis, in countries other than those of origin. Some 100 European patents are now selected, it is stated, for offer to American manufacturers, including machine tools, electrical devices, temperature measurement, air conditioning and welding processes.

EIGHT CARLOADS of the new General Electric oil-burning furnaces were shipped to New York City recently from the Pittsfield, Mass., factory of the company to meet the unusual demand which cool weather brought upon the New York distributors. "Business in the past two weeks has been so brisk that our factories are being pressed hard to keep up with the demand," J. J. Donovan, manager of General Electric's air conditioning department, declared. "Although this is the first season for our new oil furnace, it seems to have met with instantaneous approval by the public."

AS A RESULT of a trip of investigation to England made by Howard H. Bristol, president of the Bristol Co., Waterbury, Conn., that company announces the establishment of a British factory at 144 Pomeroy St., New Cross, London, with office, manufacturing and testing equipment for its complete line of instruments. The plant will be opeerated under the name of Bristol's Instrument Co., Ltd., Mr. Bristol is chairman of the board of directors, Alexander L. Dugon of J. W. & C. J. Phillips, Ltd., who have acted heretofore as sales agents, is Vice Chairman and Managing Director.

JOHN B. FOLEY, Jr., 510 Hills Building, Syracuse, N. Y., has been appointed Syracuse district sales representative for the Power Plant Eqiupment Division of The Swartwout Co.

GARDNER-DENVER CO., Quincy, Ill., announces the appointment of the Southern Machinery & Supply Co., Roanoke, Va., as its agent for rock drills, portable and stationary air compressors, steam and power pumps.

ROBERT E. DOHERTY, professor of electrical engineering at Yale University has been appointed by President James R. Angell as Dean of the newly organized School of Engineering there. Professor Doherty graduated in electrical engineering from University of Illinois in 1909 and went to General Electric Co., where he became a close associate of the late Dr. C. P. Steinmetz in solving mathematical problems in engineering arising in the work of the company. He organized advanced courses for engineering graduates at the Schenectady plant in design engineering which were recognized as a distinct contribution to technical education and, in 1931 was appointed Professor of Electrical Engineering at Yale. He believes in a broad educational background for engineering students, including modern and classical languages, history and literature.

R. H. GARRISON, formerly general sales manager of Universal Motor Co. has become vice-president in charge of merchandising of Marble-Card Electric Co., Gladstone, Mich., the latter having recently retooled its plant for larger production of a.c. motors up to 100 hp. and d.c. motors up to 75 hp.

ERIE CITY Iron Works, Erie, Pa., has appointed J. R. Steward as district sales agent at 17511 Pennington Drive, Detroit, Mich., and Fred S. Renauld, district agent for southern California at 1816 W. 75th St., Los Angeles, Calif.

AT THE gathering of engineers in Chicago during Engineering Week, June 25-30, 1933, it is expected that 14 engineering societies will hold national meetings, including the A.S.M.E., A.I.E.E., A.S.C.E., and A.I.M. & M. E. The Century of Progress Exposition will be open with special attention during that week to organized trips for engineers through the exhibits, also the biennial display of the Chicago Power Show will be open to visitors in the Coliseum. A special Engineers' Day is being planned by the management of the Century of Progress Exposition.

For the Engineer's Library

POWER PLANT ENGINEERING AND DESIGN. By Frederick T. Morse. D. Van Nostrand Co., New York, 1932. 813 pp., 6 by 9 in., cloth. Price, $6.50.

Professor Morse, of Louisiana Polytechnic Inst. has prepared a text for engineering students covering American practice in electric generating stations. It deals with the larger mechanical and electrical equipment, principles of action, methods of operation, economic factors in design and construction. The author assumes a knowledge by the student or reader of the physics of heat and power and the fundamentals by thermo-dynamics.

Starting with a brief discussion on power as a factor in industry and social economics, the effect of variable load is analyzed, its effect on rates and the ways of meeting resulting problems by load diversity and plant design. Next the plant building layout is considered, then types of generation by Diesels, hydro-electric and steam plants. Five chapters are devoted to steam plant equipment, covering station cycles, boilers, prime movers and condensers, coal handling and combustion, feed water treatment and handling, piping systems. Two chapters deal with equipment and layout of the electric generating and distribution systems and a final chapter is given to metering, use of records and office organization. Problems at the end of each chapter and references for collateral study complete the picture. While necessarily somewhat brief, the treatment of each section of the field is modern, covering latest practice and equipment. Principles, types and performance are treated rather than commercial details, although information has been freely drawn from manufacturers of equipment. It is a book which students should find interesting as well as informative and that will be of distinct value in the practicing engineers reference library.

ELECTRIC POWER EQUIPMENT. By J. G. Tarboux. Second Edition, cloth 6 by 9 in., 494 pages, McGraw-Hill Book Co., Inc.. 1932, price $5.00.

This book is designed primarily as a text book or reference book for students in electrical engineering who have already had a fundamental course covering electrical circuits and machinery. It is the belief of the author that students in electrical engineering should have a general knowledge of the details, operation and application of some of the more common types of electrical power equipment which are now available. For this reason the scope of the book is broad, the author apparently seeking to comprise the most essential elements of all electrical equipment so that the student may obtain a bird's-eye view of the entire field of electrical power equipment. Starting with a brief survey of power resources, he studies prime movers, the relation of steam to water power, a discussion of loads and load graphs, then taking up such topics as generating equipment, synchronous generator excitation, power plant circuit layouts, switching equipment, transformers, meters and measurements and other electrical equipment. The book closes with a short chapter on the economics of electric service.

This book was first published in 1927 but since that time the electrical engineering field has expanded a great deal and so the book has been revised.

RE-WINDING AND CONNECTING ALTERNATING CURRENT MOTORS. By Daniel H. Braymer and A. C. Roe. First edition, cloth, 6 by 9 in., 372 pages, illustrated. McGraw-Hill Book Co., Inc., New York, 1932, Price $3.50.

This book appears to supply a long-felt need to the man who is occasionally called upon to re-wind or re-connect alternating current motors. It is designed to serve as a reference for practical procedure in applying and checking lap and wave winding in alternating current motor stators and rotors. It is a book for both the practical man in the shop or plant and technically trained man who has not been able by frequent contact to familiarize himself with the details of the various alternating current motor windings.

The authors are well qualified to present such a book. Mr. Roe has for a long time been in charge of the renewal parts engineering department of the Westinghouse Electric & Manufacturing Co. and was formerly with the New York and Detroit Service Departments of the same company. Mr. Braymer formerly was editorial director of Industrial Engineer. He is also very familiar with the motors under discussion.

Realizing the need for practical information, the authors have presented the following material in a form that can be quickly located when needed: The Essential features of design and advantages of particular windings; constructing and checking any type of alternating-current winding diagram; rules for modifying an existing winding; duplicating any existing standard or special lap or wave winding; laying out a new winding in an old stator for any change in operating condition with step by step details on each operation with examples; determination of the reconnections possible and practical for any stator or rotor; examples to provide the "why" and "how-to-do-it" viewpoint; practical tables and diagrams that a shopman can use with the assurance that they have been checked in actual work to save time and prevent mistakes.

REWINDING SMALL MOTORS. By Daniel H. Braymer and A. C. Roe. Second Edition. Cloth, 6 by 9 in., 264 pages, illustrated. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1932. Price $2.50.

A book full of detailed information for those who have occasion to rewind small motors. As a rule such rewinding jobs are simple hand winding operations but call for the same good judgment and care as when rewinding larger motors. Two essential elements in such jobs are speed and a thorough knowledge of the kinds of windings used. There are short cuts to be learned as well as steps in performing the work that will produce the quickest and most satisfactory job from a workmanship standpoint. These factors, according to the authors, have been taken into consideration in writing this book. It is a practical man's handbook on the winding of small direct and alternating current motors rather than a textbook on the subject. The authors are well qualified to present such a book. Mr. Braymer now a consulting engineer was formerly editorial director of Industrial Engineer while Mr. Roe has for many years been connected with the repair and service departments of the Westinghouse Electric and Mfg. Co.

STEAM POWER PLANT ENGINEERING, by Louis Allen Harding. Published by John Wiley & Sons, Inc., New York. 770 p.; fully illustrated; 6 by 9 in.; cloth, 1932. Price $10 net.

This is a revision to replace Vol. II of Mechanical Equipment of Buildings which is discontinued, covering the design and rating of equipment and more fully its relations as assembled into plants. It has, in general, three sections covering boilers and boiler room equipment, engine and turbine plants and accessories, power plant cycles, heat balance and arrangement. In the first section, Chapters I to VII deal with fuels, combustion, boilers and furnaces, draft, fuel feeding, superheating, feedwater treatment and heating, and pumps; Chapters VIII to X are on engines, turbines and condensing equipment; Chapters XI to XIII treat of cycles and heat balance, piping systems and plant arrangement.

In each section the treatment of details of construction and action are exceptionally complete and performance data are embodied in equations, curves and tables showing practical results obtained in actual plants and to be expected of well-designed and operated layouts. It is up to date in plant methods and performance, logical and clear in discussion of principles, thorough in analysis of factors affecting operation and as simple as possible in mathematical treatment of problems. On the whole it is a well-planned and executed work by an experienced engineer and will be helpful to anyone who has to deal with engineering of steam power plants.

EMBRITTLEMENT of Hot Galvanized Steel, published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., is the result of an investigation made at the Battelle Memorial Institute, and deals with the proper practice to safeguard against embrittlement of hot galvanized structural steel products and the procedure necessary for detecting embrittlement.

Over 170 heats of bessemer, duplex and open hearth steel in the as rolled, pickled and galvanized conditions, with punched and drilled holes, were examined in several thousand tests. The results of these are summarized. In addition, there is a brief history of the problem, outlines of the testing methods used and a careful analysis and interpretation of these tests. The 109-page paper bound book sells for $1.00.

SINGLE-STAGE centrifugal pumping units made by Pennsylvania Pump & Compressor Co., Easton, Pa., are described and illustrated in a 12-page catalog, Bulletin No. 218.

INSULL COMPANY REPORTS. Published by the Government Printing Office and sold by the Superintendent of Documents, Washington, D. C. 6 by 9 in. paper bound. Senate Document 92; Part 38, 826 pa., $0.80; Part 39, 617 pa., $0.60; Part 40, 507 pa., $0.50.

Printed transcript of testimony given and exhibits introduced in public hearings of the Insull owned companies and subsidiaries before the Federal Trade Commission in response to Senate Resolution No. 83, 70th Congress. Part 38 deals with the Middle West Utilities group, including L. E. Myers Co., North West Utilities Co., Mississippi Valley Utilities Investment Co., United Public Service Co. and United Public Utilities Co. Maps are included showing lines and territory served.

Part 39 contains the record for the North American Light & Power Co., a corporation jointly owned by the Insull interests, the Studebaker interests and the North American Co.

Part 40 covers the National Electric Power Co., Electric Management & Engineering Corp. and the National Public Service Corp., each a part of the Insull groups. Reports of other units in Florida, New England and Illinois will be covered in Part 41 to be published later.

RECOMMENDATIONS for oil-refining heat exchange equipment are given in a recent publication by the Petroleum Division of the American Society of Mechanical Engineers, 29 W. 39th St., New York. This is a 16 page, 8½ by 11 in. pamphlet, with recommendations covering a definite outline of procedure for design, construction practice and testing of the heat exchange equipment intended for the oil refinery service. Price of the pamphlet is 50 cents to members of the A.S.M.E. and 75 cents to non-members.

STEPHENS-ADAMSON Mfg. Co., Aurora, Ill., has acquired the manufacturing and sales rights of the Redler conveyor and in a descriptive folder tells of its claims to handle material, horizontally, vertically, on inclines and around corners.

FORD, BACON & DAVIS Inc., 39 Broadway, New York City, have prepared a form to assist in making application to the Reconstruction Finance Corp., which gives matter from R.F.C. circular No. 3 and provides space for assembling the necessary legal and technical information to show nature and cost of project, financing plans, credit data and method of liquidation.

REEVES Vari-speed motor pulley, design and uses, is described in catalog V-200 of the Reeves Pulley Co., Columbus, Ind.

LUNKENHEIMER Bottle Oilers for journals are described in an 8-p. catalog, booklet No. 532, recently received from The Lunkenheimer Co., Cincinnati, Ohio.

FAFNIR Bearing Co., New Britain, Conn., announces the 6th edition of its engineering data book on ball bearings.

GENERAL Refractories Co., Philadelphia, Pa., is sending out bulletins on its Carbex brick, giving characteristics and applications for boiler and industrial furnaces.

FREYN Design, which is issued occasionally by Freyn Engineering Co., 310 S. Michigan Ave., Chicago, gives in the October issue data on plants in Russia, South Africa and England.

BUILDERS IRON FOUNDRY, Providence, R. I., in bulletin No. 262, describes long distance demonstration of the action of Chronoflo meters for water levels, pressures and rates of flow.

REVISED bulletin 15 describing the new Ellison portable draft gage sets, series 35, with a chapter on, How to Use a Draft Gage in Domestic Heating Plants, is issued by Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill.

GENERAL ELECTRIC Co. announces an air conditioner for warm air systems, designed for use with its oil-burning warm air heater. Air is circulated through heat exchangers, humidifying screens, the duct system and back to the basement, being delivered to registers at 125 to 135 deg. F. Recirculation is 5 to 10 times an hour for all air in the house at continuous operation.

ECONOMY PUMPING MACHINERY Co., 3431 W. 48th Place, Chicago, Ill., is issuing new catalogs, bulletins 426 and 427 describing and illustrating two-stage, opposed-impeller centrifugal pumps for medium size water supply, and non-clogging sewage ejector pumps of submerged type. The former are horizontal, split-case, ball bearing, the latter vertical. Bulletin 427 gives data for calculating sewage pump capacities, also sump and basin dimensions.

SEATRAIN SHIPS, as used for transporting railroad cars at sea, carrying 100 freight cars and driven by 8000-hp. geared marine turbines are described in a reprint article issued by DeLaval Steam Turbine Co., Trenton, N. J.

NATIONAL CARBON Co., Inc., Carbon Sales Division, Box 400, Cleveland, Ohio, has recently issued three new bulletins covering the application of Gredag lubricants, known as sections G-132, 232 and 332. The first gives a description of all grades and a general treatise on lubrication; the second applies specifically to lubrication of outdoor equipment and the third covers lubrication of industrial equipment.

NEW DEVELOPMENTS in angle compound air compressor design are featured in a 32-page catalog of the Sullivan Machinery Co., 400 North Michigan Avenue, Chicago, Ill., just issued, illustrating different types. Particular attention is given to partial capacity operation, to adaptability, to economies of multi-step control and to automatic control.

A NEW ILLUSTRATED 16 page publication C-1907-B, entitled, Mercury Arc Rectifiers has been issued by the Westinghouse Electric and Manufacturing Company.

LOWER POWER COSTS is the title of the new Catalog 932F of the Atlas Imperial Diesel Engine Co., Oakland, Cal. It is a 32 pa. booklet, printed black on aluminum and illustrated by photographs of recent installations in all parts of the country and in all industries.

A 20 page illustrated leaflet describing the features, characteristics and applications of the Westinghouse FlexArc welders has recently been published by the Westinghouse Electric and Manufacturing Company. Copies of this publication entitled, Westinghouse Arc Welding Data Bulletin No. 16 are available at the nearest district office, or direct from the Advertising Department, East Pittsburgh, Pa.

STAINLESS STEELS and Their Uses are descussed at length in a 20-p. booklet issued by Electro Metallurgical Co., 30 E. 42nd St., New York City.

SARCO temperature regulators for brine control in refrigeration is the subject of a 4-p. bulletin issued by Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

SPRAY COOLING Equipment made by The Marley Co., 1737 Walnut St., Kansas City, Mo., is the subject of a 16-p. bulletin, No. 37 giving details of the system and illustrating methods of use.

ELECTRIC-HEATED steam boilers in sizes from 1/5 to 8¾ hp. to furnish process steam are described in bulletins Nos. 41 and 52 of the Commonwealth Electric and Mfg. Co., 83 Boston St., Boston, Mass.

ECONOMICAL HEATING is discussed in a 16-page catalog describing the use of Convectofin built in heaters, issued by Commodore Heaters Corp'n, 11 W. 42nd St., New York, N. Y.

CATALOG L-10 of the De Laval Steam Turbine Co., Trenton, N. J., shows IMO rotary oil pumps in capacities from 4 to 460 g.p.m., and for pressures up to 200 lb.

LINC-WELD Type D motors, made by Lincoln Electric Co., Cleveland, Ohio, are described and their extra horsepower features explained in a recent bulletin.

MORSE Roller Chain drives are described, with details of dimensions and prices in bulletin No. 51 of the Morse Chain Co., Ithaca, N. Y.

DETROIT Multitple Retort Stoker as made by the Detroit Stoker Co., General Motors Bldg., Detroit, Mich., is described in detail in a new 12-p. catalog, which also shows operation and installations.

VASCO conveyors, made by Vacuum Ash and Soot Conveyor Co., Wilson Ave., Newark, N. J., are discussed in a leaflet just received.

PAINT as a factor in effective lighting of rooms is discussed, with results of laboratory experiments, in a booklet, Using Paint as Light, issued by The New Jersey Zinc Co., 160 Front St., New York City.

RATES, REVENUES AND RESULTS of Municipal Ownership of Water Works in the U. S. By R. E. McDonnell Published by the Burns & McDonnell Engineering Co., 417 East 13th St., Kansas City, Mo. 6 by 9 in. paper bound, 56 p. Price $1.00.

History, general information and operating data of municipal water works in the United States. In addition to the data of operation, revenue and expenses of the plant, there are chapters devoted to arguments in favor of municipal ownership, methods of acquiring water systems and methods by which these systems may be financed.

RESULTS OF AN INVESTIGATION made by the Hartford Steam Boiler Inspection & Insurance Co. on a number of samples of welded plates received from manufacturers of fusion welded unfired pressure vessels are tabulated in a mimeographed report being distributed by the engineering department of the above company at Hartford, Conn.

SCIENCE IN ACTION. By Edward R. Weidlein and William A. Hamor. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Size 6 by 9 in., cloth, 287 pages, Price $3.00.

In the present trade depression industrial research is being carried on extensively in many branches as though no unusual condition existed. The chemical industry, for instance, is in a particularly advantageous position due largely to well organized, wisely managed research staffs.

How these research organizations work, the relation between pure science and industrial research and what they have accomplished is set forth in this book. It is intended to give laymen an idea of scientific research and progress, to be of help to those interested in scientific careers in industries and to help those workers who are interested in what other laboratories are doing.

Power Plant Construction News

Ariz., Phoenix—Consolidated Steel Pipe & Tank Co., Phoenix, Franklin Hegeman, president, plans installation of electric power equipment in new one-story steel plant, 80 x 150 ft., estimated to cost about $70,000. Installation will include an electric traveling crane.

Calif., Alameda—Board of City Trustees is considering a report submitted by Burns-McDonnell-Smith Engineering Corporation, Western Pacific Building, Los Angeles, Calif., consulting engineer, for a proposed municipal steam-turbine electric light and power plant, with initial capacity of about 15,000 kw., estimated to cost about $1,000,000. Early decision will be made by city on project.

Calif., Los Angeles—Monarch Refineries, Inc., 412 West Sixth Street, Charles W. Fourl, president, plans installation of pumping machinery and auxiliary equipment in proposed new oil refining plant in Signal Hill district, near Los Angeles. Cost reported over $90,000.

Calif., Pasadena—Municipal Light and Power Department has purchased property on North Santa Anita Avenue, and plans construction of a new power substation on site, 380x416 ft., to cost over $175,000, with equipment. Engineering department will be in charge.

Calif., San Diego—Aztec Brewing Co., recently organized by Herbert L. Jaffe, San Diego, and associates, plans installation of electric power equipment, tanks and other mechanical equipment in proposed new brewing plant. Company has acquired former local mill of Savage Tire Co., and will remodel and equip for plant. Cost over $150,000. Richard Griesser & Son, 64 West Randolph Street, Chicago, Ill., are architects and engineers.

Calif., San Francisco—Shell Oil Co., 100 Bush Street, plans installation of pumping machinery, power equipment and other mechanical equipment at oil refineries at Wilmington, Martinez and Oilfields, Calif., in connection with a 1933 expansion and improvement program, for which a fund of over $7,000,000 is being arranged. Company engineering department will be in charge.

Colo., Denver—Bureau of Reclamation, Denver, will receive bids until Feb. 3 for three, four or five 115,000-hp. vertical shaft, hydraulic turbines, with or without butterfly type shut-off valves; and for one or two 55,000-hp. vertical shaft hydraulic turbines, and for one or two governors for such units, for installation at Hoover Dam power plant, Boulder City, Nev. (Specification 540.)

Ga., Nahunta—Brantley County Utilities, Inc., Nahunta, recently organized by Sylvan Byck, Savannah, Ga., and associates, has secured local electric light and power franchise, and franchise for water system. Plans early construction of Diesel engine power plant and distributing system, and waterworks station. Cost over $90,000, with equipment.

Ga., Valdosta—City Council has appointed a committee, headed by A. A. Parrish, to arrange for extensions and improvements in municipal waterworks station and system. Installation will include an oil-burning engine, electric dynamos, pumping machinery and auxiliary equipment. Estimated cost close to $100,000.

Ind., Fort Wayne—Board of Works, City, Hall, is asking bids until Jan. 5 for equipment for municipal electric power station on Clinton Street, in connection with extensions and improvement in plant to cost about $150,000. Also, at same time, for construction of high-tension underground transmission line from station noted to site of hydroelectric power development. Latter project is reported to cost over $750,000. Froelich & Emery Engineering Co., Second National Bank Building, Toledo, Ohio, is consulting engineer.

La., Lake Grande Ecaille—The Freeport Sulphur Co., 122 East Forty-second Street, New York, affiliated with Freeport Texas Co., same address, has plans under way for a new 5000-hp. power plant at proposed new sulphur works at Lake Grande Ecaille (Lake Washington), about 45 miles from New Orleans. Project will also include a pumping station and water-treating plant, and is estimated to cost close to $1,500,000. J. F. Coleman Engineering Co., Hibernia Building, New Orleans, is consulting engineer.

Mass., Lee—Eaton-Dikeman Co., Lee, plans construction of new boiler plant in connection with proposed rebuilding of paper mill, recently destroyed by fire. Electric power equipment will be installed in mill. Fire loss totaled over $150,000, with equipment. Calvin C. Yates is president and general manager.

Mo., Joplin—Empire District Electric Co., Joplin, has secured permission to construct and operate a hydroelectric generating plant on the White River, Taney County, Mo., near Table Rock. Project will include power dam, generating station, power substations and switching stations, and transmission lines. Ultimate development will total about 220,000 hp., and is estimated to cost over $25,000,000. Work will soon begin. Company engineering department is in charge.

Neb., Austin—Dr. J. E. Bowman, Loup City, Neb., is at head of company now being organized, to construct and operate a hydroelectric power plant on the Middle Loup River, vicinity of Austin. The Henningson Engineering Co., Union State Bank Building, Omaha, Neb., has been engaged to prepare plans. Entire project reported to cost close to $100,000, with transmission line and irrigation system.

N. Y., Brooklyn—Kings Brewery, Inc., operating old Excelsior Brewery, 227-81 Pulaski Street, plans construction of new power house in connection with an expansion and modernization program at brewing plant. A new refrigerating plant will also be installed. Entire project will cost over $1,000,000. Shampan & Shampan, 188 Montague Street, Brooklyn, are architects.

N. Y., Nassau Heights—New Amsterdam Brewing Co., 10 East Fortieth Street, New York, will build a one-story power plant at new brewery at Nassau Heights, Queens Borough, where large tract of land has been acquired. Work on project will begin early in 1933. It is estimated to cost about $2,000,000. Herbert L. Noll is president. C. Dale Badgeley, 24 West Sixty-ninth Street, New York, is architect.

Ohio, Amherst—Village Council has plans under way for a municipal electric light and power plant, for which bond issue of $100,000, was recently authorized. Understood that bids will be asked at early date. F. N. Straus, 2613 Queenstown Road, Cleveland, Ohio, is engineer.

Ohio, Williamsburg—Village Council will have plans prepared at early date for a municipal electric light and power plant, for which a bond issue of $90,000 has been authorized. Preliminary surveys were made by W. S. Herr & Co., Terre Haute, Ind., engineers, and it is understood that detailed plans will be drawn by same company.

Okla., Hominy—City Council has accepted proposition tendered by Trans-American Construction Co., Philtower Building, Tulsa, Okla., for construction of a municipal electric light and power plant to cost $135,000, such to be defrayed from revenue of plant. Last noted company will purchase and install equipment. V. V. Long & Co., Colcord Building, Oklahoma City, Okla., are consulting engineers.

S. D., Aberdeen—City Council will receive bids until Jan. 12 for equipment for proposed municipal electric light and power plant, including Diesel engine-generating units, oil-operated; water cooling tower and accessories; switchboard and auxiliary apparatus; electric distributing system and miscellaneous equipment. Plant estimated to cost close to $850,000. J. W. Henry, First National Bank Building, Aberdeen, is architect; Bemis Co., 105 West Adams Street, Chicago, Ill., is consulting engineer.

S. D., Rapid City—City Council has had surveys and estimates of cost made for a proposed municipal electric light and power plant, and is considering following alternates: Hydroelectric station, estimated cost $950,397; steam-operated electric plant, $582,536; and oil-operated electric plant, $573,677. Early decision is expected on type of plant. Black & Veatch, 405 East Thirteenth Street, Kansas City, Mo., are consulting engineers.

Texas, Corpus Christi—Texas Co., 135 East Forty-second Street, New York, N. Y., plans installation of tanks, pumping machinery and other mechanical equipment in connection with new oil storage and distributing terminal at Corpus Christi. Entire project reported to cost about $100,000. Company engineering department is in charge.

Texas, Plainview—Common Council is having plans drawn for a municipal electric light and power plant. Cost reported over $75,000, with equipment. Montgomery & Ward, Wichita Falls, Texas, are consulting engineers.

Wash., Eatonville—Eatonville Lumber Co., Eatonville, is said to be planning installation of boiler house equipment and other power equipment in connection with proposed rebuilding of portion of lumber and saw mills, recently destroyed by fire with loss reported over $300,000.

W. Va., Huntington—North Pole Ice Co., Huntington, has acquired a two-story building on Third Avenue and Twenty-third Street, and will remodel and equip for new ice-manufacturing plant. Cost over $50,000, with equipment.